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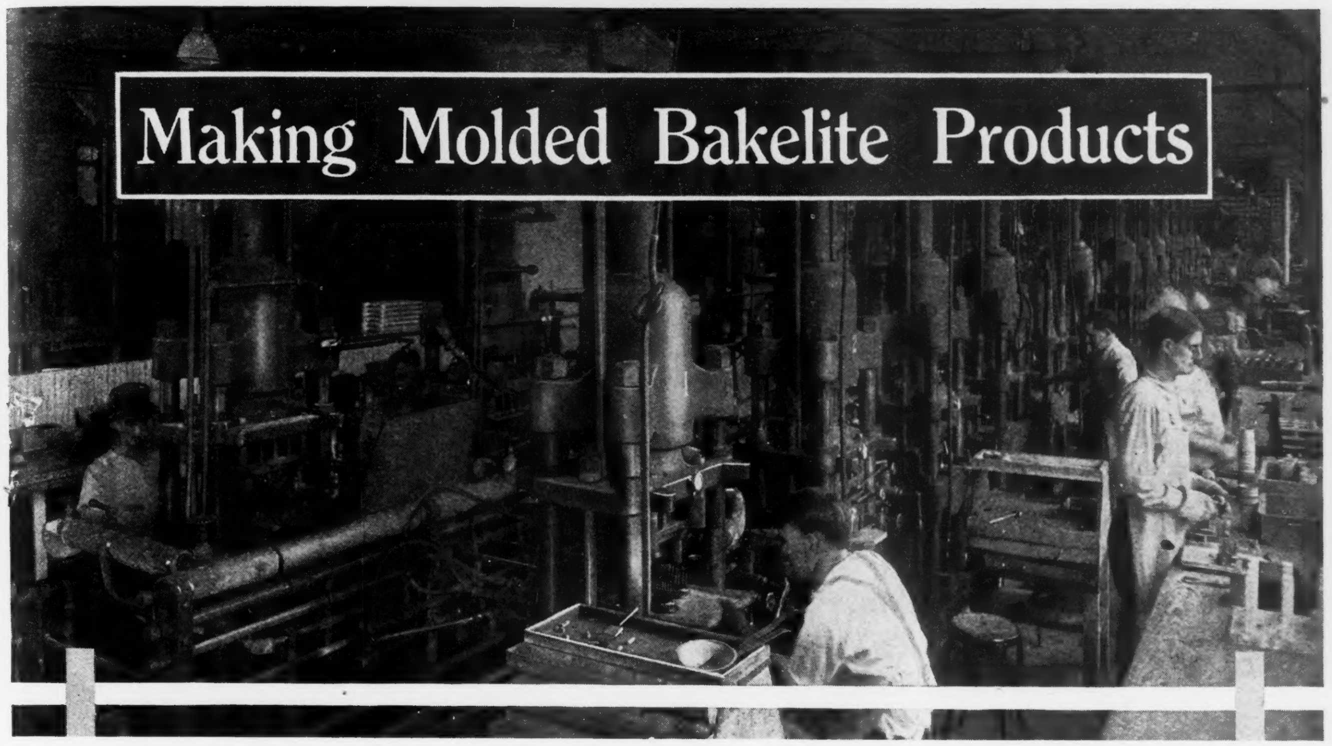


Making Molded Bakelite Products

Designing and Making Dies with Provision for Heating with Steam

By Edward K. Hammond, Associate Editor of MACHINERY

APPLICATIONS of bakelite in industrial work are of relatively recent date, but this material is adapted for such a variety of purposes that it is now being employed in the manufacture of a great number of different products. One of the most important uses of bakelite is for making electrical insulators, and it is with the operations that are involved in molding this particular class of products that this description is concerned. It will be of interest to note, however, that bakelite is finding successful application in making tobacco pipe stems, billiard and pool balls, and many other products, so that the methods described for molding bakelite insulators could be applied, with certain modifications, in the manufacture of many other products made from this material.

Bakelite is a compound made from formaldehyde, carbolic acid, and wood pulp, which are subjected to the necessary conditions of temperature, etc., in order to carry out the chemical process of converting these constituents into a suitable grade of material. So far as its application in the industrial arts is concerned, bakelite possesses an important advantage over many other materials, in that almost any shade of dye may be applied to color the product, which is naturally a most important consideration when making pool balls and various toys and specialties. At the plant of the Dayton Engineering Laboratories Co., Dayton, Ohio, the bakelite used in the manufacture of insulators is purchased from the General Bakelite Co. of New York City. A great variety of bakelite insulators are molded at the "Delco" plant for use in connection with various types of ignition and self-starting systems used on motor cars and airplanes. In order to describe the methods which are employed in handling this work and making the dies in which the molding operations are performed, this article will concern itself with the work of making the distributor head for the ignition and self-starting system used on a Buick six-cylinder engine.

In this article there is presented a description of the equipments and methods used in molding bakelite products. Bakelite must be molded under high pressure and temperature. An explanation is given of the design and methods of making dies for use under hydraulic presses which supply the necessary pressure, and of how the temperature is obtained by passing superheated steam through ducts cut in the die bodies. The description refers to the manufacture of a specific product, but the methods described are of general application.

Before proceeding with a description of the process of making this distributor head, it will doubtless be advisable to present a brief description of the head for the benefit of those who are not already familiar with its construction. Referring to Fig. 1, it will be seen that at the center of the head there is an electric terminal, and on the under side a bearing is provided for a brush which rotates in order to come successively into contact with each of the six terminals that are mounted in the head. As the brush comes into contact with each of these terminals, it closes the electric circuit and results in creating a spark which ignites the charge in the engine cylinder corresponding terminal with which the brush is in contact. The body of the head is made of bakelite,

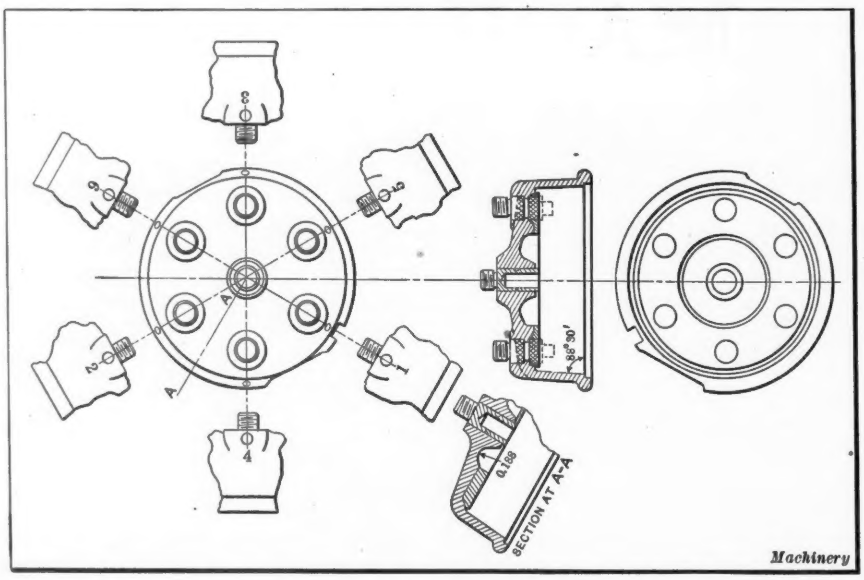


Fig. 1. Distributor Head for Automobile Ignition System. This Head is molded from Bakelite

but experience gained with the use of this material showed that it was not particularly well adapted to withstand frictional resistance of the brush which runs in contact with the under surface of the distributor head.

The difficulty experienced was that the brush showed a tendency to shred off small particles of metal from the faces of the terminals, and it was found that these particles then became embedded in the surface of the bakelite between successive terminals. After the head had been in operation for a considerable length of time, this accumulation of metal embedded in the surface of the bakelite often became sufficient to form an electrical connection between successive terminals, thus causing short circuits. Various methods were tried to overcome this difficulty, and one of the most successful of these, which is in use at the present time, was to insert a hard rubber track in the bakelite head so that the brush runs from terminal to terminal in contact with this hard rubber track instead of with the bakelite. The rubber is sufficiently hard so that particles of metal shredded off from the terminals will not easily become embedded in its surface.

Making the Rubber Track

In making a distributor head of the type shown in Fig. 1, the method of procedure is first to make the rubber track and while the rubber is still soft, the electric terminals are inserted at the proper positions, after which the entire piece is vulcanized in order to give the rubber the desired degree of hardness. After this process has been completed the rubber tracks with the terminals in place are taken to the molding department where each one is inserted in a die and the bakelite is molded around it. Having made this brief statement of the order of procedure followed in making distributor heads, we are ready to proceed with the detailed description.

The ingredients used in making the rubber track consist of washed crude rubber and various ingredients with which it is compounded to produce the desired physical properties. This raw material (with the exception of the rubber) is first placed in a pebble mill, that is, a type of tumbling barrel in which the material is thoroughly pulverized. Attention is called to the fact that it is the ingredients of the compound added to the rubber which are pulverized and mixed in this mill, and not the rubber itself. Strips of washed crude rubber are now rolled on the steam-heated roller shown in Fig. 2, and during this process of rolling at high temperature, shellac and the compound which has already been mixed and pulverized are added to the rubber. The result is that the crude gutta-percha or raw rubber is rolled down into a sheet approximately 1/4 inch thick, which has somewhat the appearance of certain grades of rubber floor covering. These sheets of rubber are next transported to a power press equipped with suitable dies for blanking out rings of the required diameter for the rubber tracks which are to go inside the distributor heads. In addition to being blanked, these rings are also pierced to provide holes in which the electric terminals can be inserted ready for the vulcanizing operation. After these blanks have been made, they are placed in molds or forms of the type shown in Fig. 3, and the "metal inserts," or electric terminals, are put in place, after which a pressure of 3000 pounds is applied in order to cause the rubber to flow in around these inserts and secure them in the desired positions. Reference to Fig. 3 will show that each mold holds two rubber rings or tracks, and there are an upper and a lower section to each mold in which cavities are provided to receive each rubber ring and the metal inserts or electric terminals which it is to carry. Sufficient clearance is provided around the metal inserts so that when the mold is closed, pressure may be applied by a hydraulic press in order to compress the rubber around the metal inserts to hold them firmly in place.

As each mold is removed from the press, it is placed on a truck ready to be transported to the vulcanizing department. The process of vulcanization consists of putting the

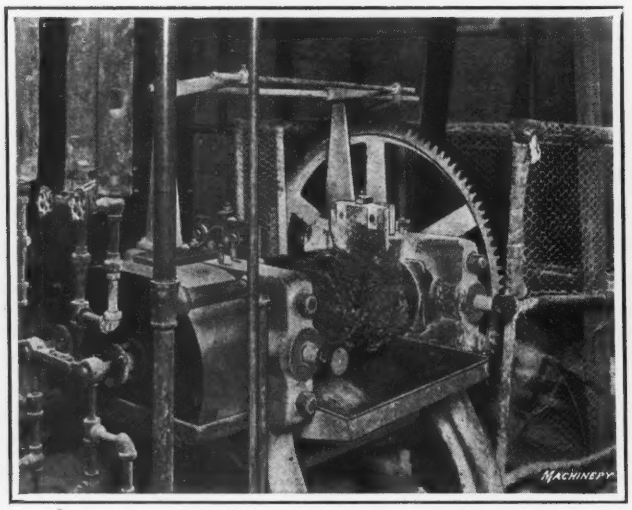


Fig. 2. Steam-heated Rolls on which Rubber is compounded and rolled into Sheets

Fig. 3. Placing Rubber Rings or "Tracks" into Molds in which they are vulcanized

molds containing two rubber tracks into a steam-heated chamber, where they are maintained at a steam pressure of 75 pounds per square inch for one hour. This steam pressure corresponds to a temperature of 320 degrees F., and the result of the treatment is to convert the rubber from a red colored, flexible and rather soft material, into the hard black material with which most people are familiar. After the molds are removed from the vulcanizer, the vulcanized rubber tracks are taken out and the molds are used over again while they are still hot, in order to effect an economy in the use of fuel. The vulcanized rubber tracks are next packed in powdered soapstone and put into another steam-heated vat where they are allowed to "cure" for a period of four hours at a temperature of 320 degrees F. After being removed from this curing oven, the rubber tracks are ready for use, and they are sent to the molding department.

Weighing out the Bakelite

Bakelite used at the "Delco" plant for molding insulators for electrical equipment is in the form of a brown powder which is shipped to the factory in steel barrels. Brown is the natural color of the bakelite, and the material used is not dyed because the distributor head is made for utility, and brown is just as satisfactory as any other color that could be produced by adding dye for the purpose. Bakelite is quite an expensive material, and with the view of effecting as great an economy as possible in its use, the practice has been adopted in the "Delco" plant of weighing out exactly the proper charge required to make each type of distributor head. These individual charges are sent to the molding department in small paper cups. This practice not only effects an economy in the use of bakelite, but it also is the means of greatly facilitating the work of molding and preventing trouble being experienced from an excessive amount of material being placed in the molding dies. It is probable that this would give trouble through the production of excessively large fins on the work and the accumulation of an unnecessary amount of scrap material around the presses, if more serious trouble were not experienced through preventing the dies from operating satisfactorily. Fig. 4 shows one of the girls who are employed to weigh out the bakelite powder ready to be sent to the molding department. It will be seen that she has a number of the small paper cups at the left-hand of the scales, into which charges of material are poured as fast as they are weighed out.

How Molding Operation is Performed

The successful molding of bakelite products requires the combination of a high pressure and high temperature. This result is obtained by performing the molding operation in dies which are operated under hydraulic presses to provide the necessary pressure, while the high temperature is arranged for by having channels cut through the upper and lower die members, through which high pressure steam is allowed to circulate. In preparing for the molding operation, the first step is to locate the rubber track in the die by means of a hinged locating finger. Threaded knock-out pins are employed, these pins being provided with tapped sockets which enable them to be screwed onto the threaded electric terminals carried by the rubber track. After the molding operation has been completed and the die is opened, these knock-out pins provide for ejecting the molded bakelite insulator from the upper die in which it is held after the operation has been completed, and the upper die is raised.

After the knock-out pins have been screwed onto the terminals and the rubber track has been located in the proper position in the lower die, the hinged locating finger is swung back, after which a cupful of the bakelite, which was weighed out for the purpose, is poured into the lower die. This is shown in Fig. 5. Then the upper die is run slowly down and the operator is careful to observe that the knock-out pins screwed onto the metal inserts carried by the rubber track come into contact with corresponding knock-out pins in the upper die member. After it has been ascertained that the proper alignment has been secured, the ram is run almost to its extreme lower position, and the steam is then turned on in order to raise the temperature of the die and bring the bakelite into plastic condition. The steam is allowed to remain on for from 1/2 to 1 minute, after which the full pressure is applied for a period of from 6 to 8 minutes, in order that the combined action of high temperature and pressure may cause the bakelite, which is now in a plastic condition, to take the exact form of the molding die and also secure the desired physical properties.

Fig. 4. Weighing out the Charges of Bakelite

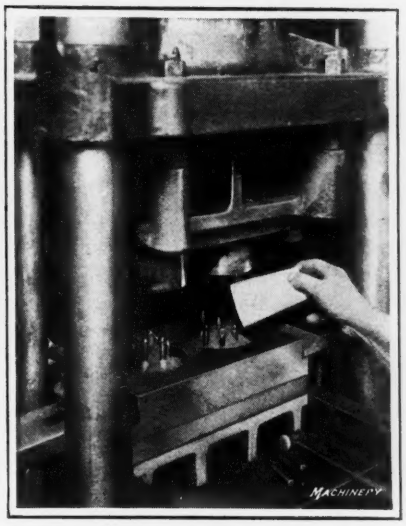


Fig. 5. Pouring the Bakelite into the Lower Die

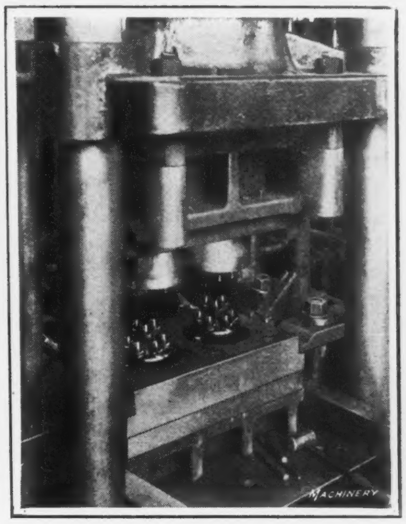


Fig. 6. Raising Upper Die after Molding Operation

After pressure has been applied for the desired length of time, the dies must be cooled in order to make it possible to handle the work without difficulty. It would, of course, be possible to simply shut off the steam, but a great deal of time would be lost if the operator were required to wait for the die to cool by radiating its heat to the surrounding atmosphere. To overcome this difficulty, each hydraulic press is provided with a double system of steam and cold water lines, so that when the steam is shut off from a die, another valve can at once be opened to allow cold water to circulate through the channels in the upper and lower die members, in order to condense the steam left in them and absorb the heat that has been retained by the die. Water is left in the dies for about two minutes, after which it is shut off and steam is again allowed to enter the die for just a sufficient length of time to counteract the contraction caused by lowering the temperature with cold water. This action of the steam is required in order to expand the die sufficiently so that the molded bakelite distributor head can

be easily removed. Fig. 6 shows the press after the upper die has been raised.

Form of Hydraulic Presses Used

Presses used for the performance of these bakelite molding operations were built by the Charles Burroughs Co., Newark, N. J., and it will be seen that they are equipped with dies adapted for molding two pieces of work at a time, the purpose being to facilitate production as far as possible. The presses are provided with rams 8 inches in diameter, and apply a total pressure of 69 tons on the material contained in the molding die. The steam used for heating the die is cylindrical steel tie-rods or guide rods, the function of which will be apparent from the following description: Attention is called to the fact that steam is always in cylinders *B* and *C;* it is only from the main pressure cylinder *A* that steam is shut off when it is desired to open the die to remove a finished piece of work. When pressure is shut off in this way, the pressure in cylinder *B* becomes effective, causing the piston in this cylinder to pull up the main ram of the press which is connected to the piston in cylinder *A*, owing to the fact that this ram is secured to two tie-rods *D* that, in turn, are connected to a cross-bar carried by the rod of the piston which runs in cylinder *B*. Cylinder *C* is known

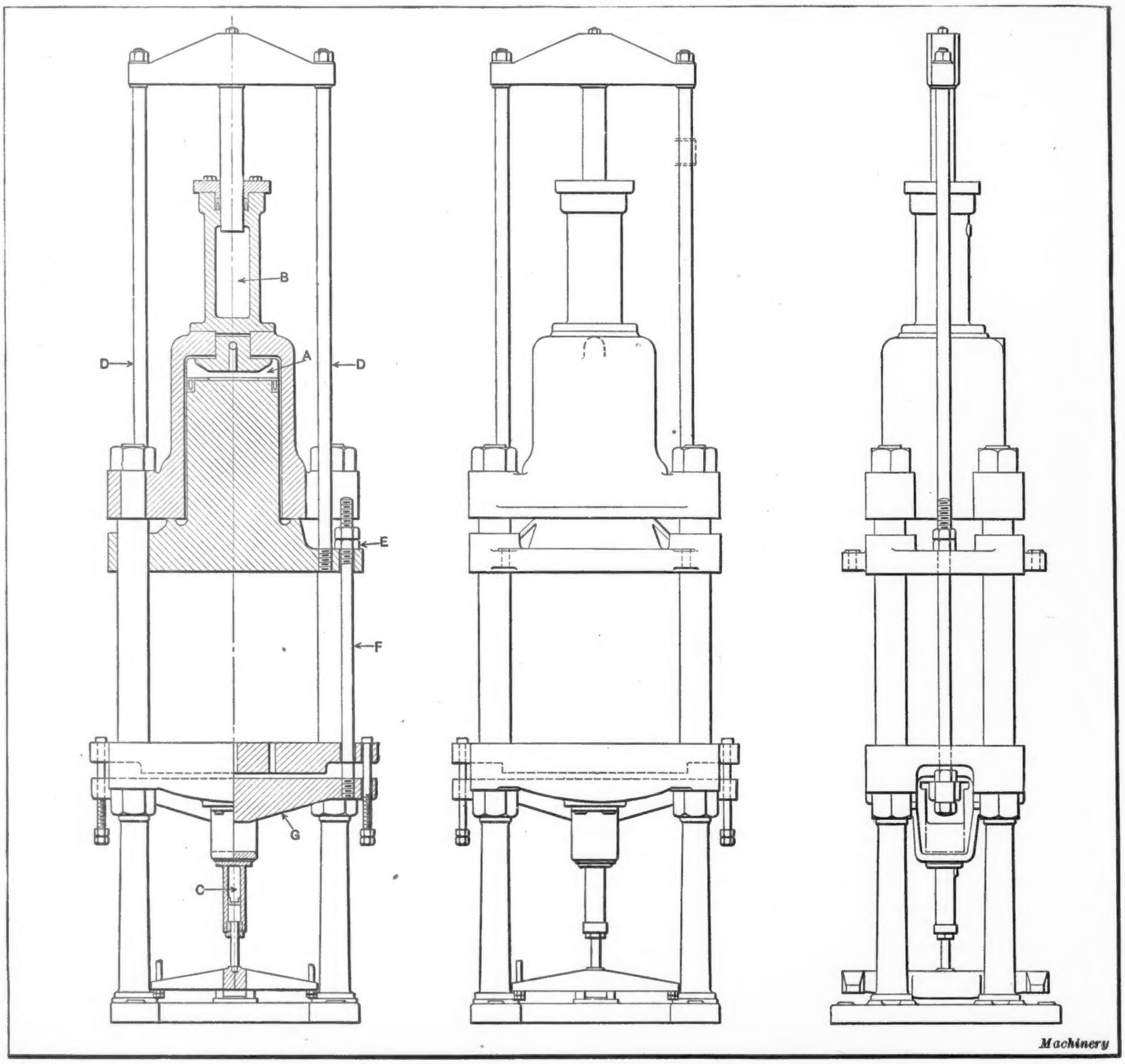


Fig. 7. Diagrammatic Outline of Hydraulic Presses under which Molding Operation is performed

at a pressure of 125 pounds per square inch, which corresponds with a temperature of 353 degrees F. As the presses used for the performance of these bakelite molding operations are of somewhat unusual design, a brief description of the way in which they operate will doubtless prove of some interest. This description can best be presented by referring the reader to Fig. 7, which shows a diagrammatic outline of the press. Here it will be seen that there are three hydraulic cylinders, namely, the main pressure cylinder *A;* a pressure cylinder *B*, which is employed for raising the ram in the main cylinder after steam pressure has been shut off from this cylinder; and a hydraulic cylinder *C*, which is employed to lower the stripper as required.

Various members of the press are connected by means of as the stripper cylinder because the function of the piston in this cylinder is to assist in the operation of a stripper which removes work from the lower die. When the piston in cylinder *B* has raised the main ram of the press to a point where it comes into engagement with stop-nuts *E* carried on guide rods *F*, on which the main ram of the press slides, continued upward movement of the main ram causes the two guide rods *F* to move upward. As a result, these rods also pull up with them the cross-bar *G* which operates a stripper working through the lower die member.

The press is now located with the ram in its upper position, and after the finished work has been removed from the die and fresh material put in place, the valves are manipulated to admit steam to cylinder *A* for the next operation. Downward movement of the piston in cylinder *A* car-

ries tie-rods D down, and hence the piston is pushed down in cylinder B against the pressure of the steam because a greater amount of power is available in the main cylinder of the press. As the main plunger moves downward, it slides down on guide rods F out of engagement with the stop-nuts E carried on these rods. As a result, cross-bar G, which operates the stripper in the lower die member, is released so that it may be returned to its starting position by means of steam pressure in cylinder C.

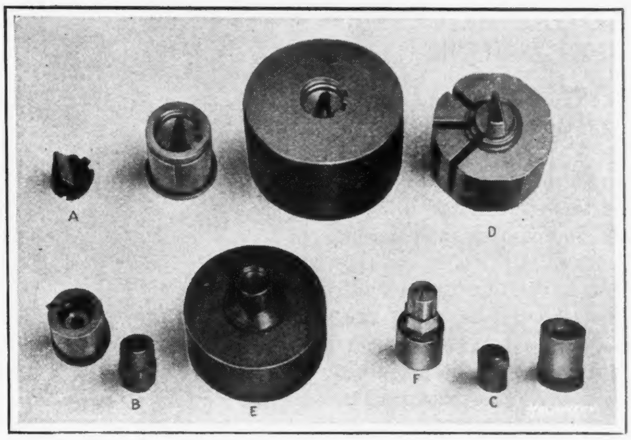


Fig. 8. Examples of Bakelite Products, Molding Dies and "Coining" Punches used in Sinking Dies

Making Molding Dies

So far this article has concerned itself only with the making of bakelite distributor heads for the ignition system used on motor car engines. In addition, the "Delco" factory makes a variety of other insulators used on electrical apparatus, and Fig. 8 shows three such products at A, B, and C, together with the dies used for making each of these products. The practice of toolmakers employed in the "Delco" shops in making these dies is sufficiently interesting to warrant the presentation of a brief description. These dies are made of machine steel and pack-hardened. One important point is to provide as large ducts as possible for carrying superheated steam or cold water through the dies for heating the bakelite and reducing the temperature of the dies, respectively, without unnecessary loss of time. In designing the dies, care must also be taken to make the size and position of these combination heating and cooling ducts such that the strength of the dies will not be weakened at points where the strain is sufficiently great to cause any danger of their being broken while in use.

In making these dies, a coining punch or "force" is employed for use in forming the die opening. This force is made of Jessop carbon tool steel and accurately machined to exactly the shape and size of the opening which it is required to produce in the molding die. The forces used for making these dies are shown at D, E, and F. These forces are pressed into the steel die-blocks under one of the hydraulic presses which is regularly used for the performance of molding operations. A pressure of approximately 3000 pounds per square inch is required to press the force into place when a hydraulic press is used, which has a cylinder 10 or 12 inches in diameter. The same force can, of course, be used for making a number of dies because the dies wear out and must be replaced from time to time. It is estimated that the use of this method of forming the die openings with coining punches or forces saves about 33 1/3 per cent of the time involved in diemaking, so that the importance of this method will be apparent when it is realized that it takes from 500 to 600 hours of toolmakers' time to make a two-unit die for molding distributor heads.

By way of conclusion, attention is called to the fact that in the production of certain bakelite products, it is advisable to deviate from the practice of pouring the charge of powdered bakelite into the die in the manner which is illustrated in Fig. 5. In some cases it would be found that if this practice were followed, the material would overflow before filling the die so that imperfect work would be produced, and the application of additional pressure would merely tend to force some of the fin back into the die space, although this result would be accomplished at the expense of an unnecessarily rapid destruction of the die. To overcome these troubles, use is made of what are known as "preformed" blanks which are made by subjecting the bakelite powder to a preliminary pressing operation which brings it into approximately the desired form for the work before being placed in the final molding die.

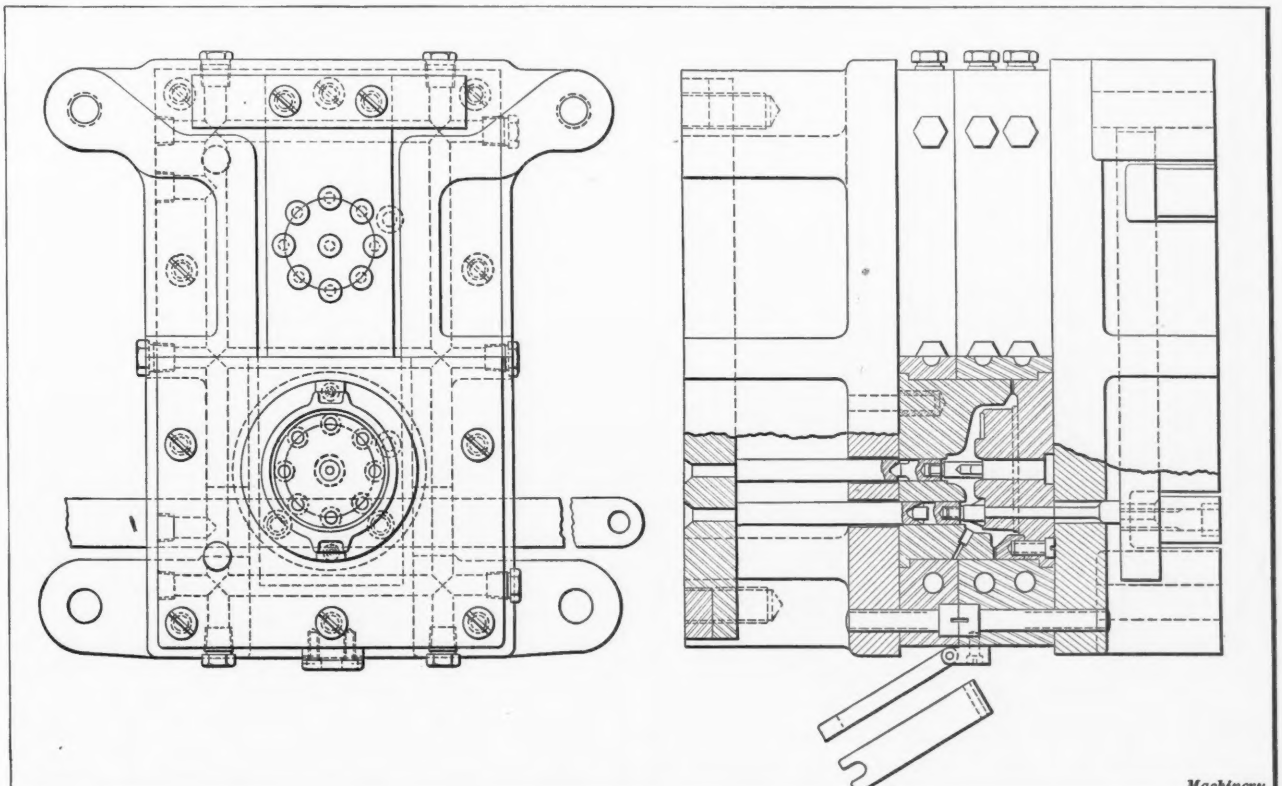


Fig. 9. Molding Die used in making Distributor Head for Ignition System of Eight-cylinder Engine. Attention is called to Arrangement of Ducts through which Steam and Water circulate in Order to heat Die for Molding Operation and to cool it for removing Work

AUTOMATIC DOUBLE-ACTING STRIPPER FOR DRAWING OPERATIONS

BY BURNETT MENKIN[1]

In Fig. 1 is shown an automatic double-acting stripper applied to a blanking and forming die. This stripper was designed by the writer, and it proved so efficient that three hundred are now being used in one factory. In the illustrations, the same reference letters indicate corresponding parts in the different views.

The base *A* has an enlarged central opening and an annular shoulder, upon which is seated the female die *B*, provided with a blanking die portion *C* and a forming die portion *D*, which is in the form of an annular rib in the opening. Operating in the blanking die is a male die member *E*, through which the plunger *F* operates. The construction as thus far described is the common type of male and female dies for forming shells *G* used in the manufacture of buttons, ferrules, etc. In this common form of die structure, the lower edge of the forming die at *H* performs the function of stripping the shell from the end of the plunger after it has been formed thereon. As a result of this constant action, the edge at *H* is rapidly worn away, thus permitting the shell to remain on the plunger until it is removed by the friction of the rib *D* within the opening *C*, the blank remaining there and choking the opening, thus interfering with the operation of the machine. Therefore, when the lower edge *H* becomes worn, it is necessary to remove the female die *D* and grind the lower surface of the flange *D* in order that it may successfully strip the shells from punch *F*. This is a source of continual annoyance and loss, as it prevents the rapid operation of the machine. In order to overcome this difficulty, the writer designed the automatic stripper that is illustrated in Fig. 2. As shown in Fig. 1, this embraces stripper fingers *K* and *L*, which are connected and held in an operative resilient position by the coil spring *M* extending through openings *N* and *O* in the heads *P* and *Q*; these heads operate upon the reduced outer threaded ends *R* and *S* of the stripper fingers. The stripper fingers are threaded at *T* and *U* to receive the adjusting nuts *V* and *W*, which provide means of adjusting the fingers to a close engagement with the upper edge of shell *G* on the downward stroke of plunger *F*, thus stripping shell *G* from the plunger. Aligning holes are provided in the base *A* and die *B*, through which fingers *K* and *L* reciprocate through the combined action of the plunger *F* and spring *M*.

[1]Address: 2141 Honeywell Ave., New York City.

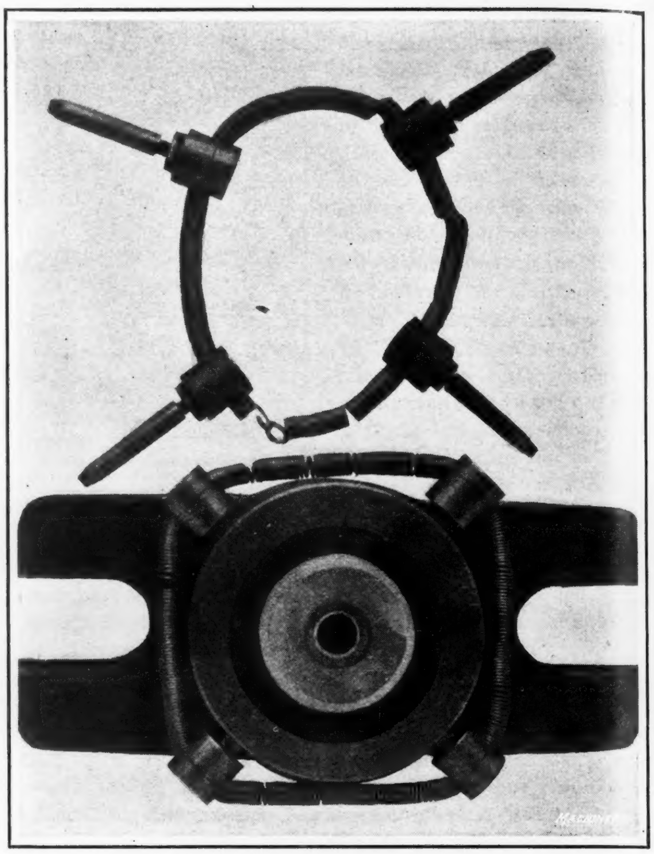


Fig. 2. General Appearance of Stripper

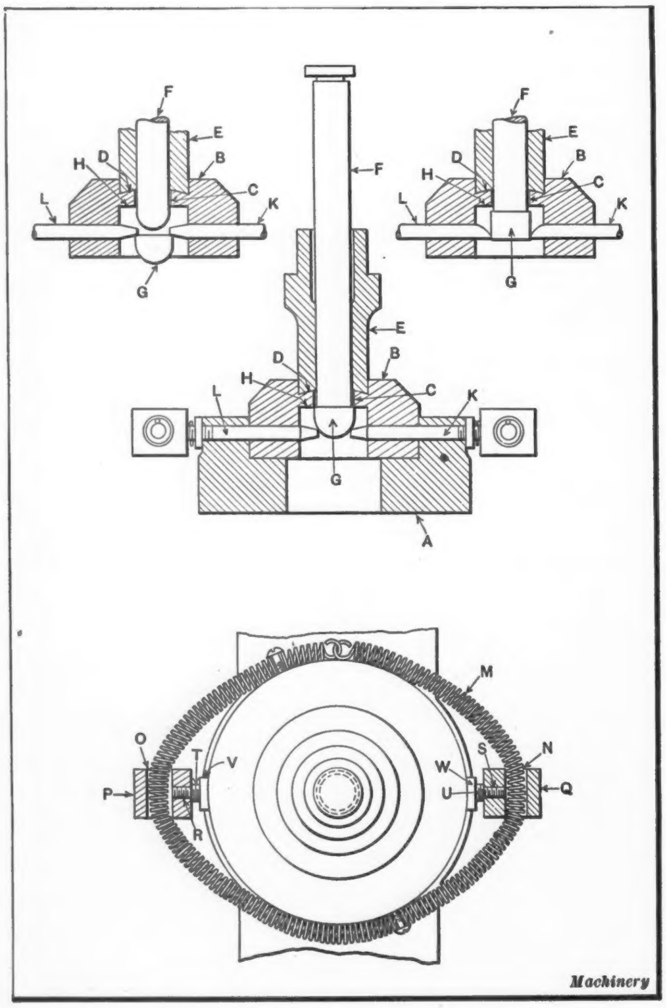


Fig. 1. Automatic Stripper for Blanking and Forming Dies

As the male die *E* descends upon the female die *B*, the blank from which shell *G* is formed is cut and seated upon the upper surface of the flange *D*, thereby being formed around the lower end of plunger *F*. The continued downward movement of the plunger forces the fingers *K* and *L* apart against the tension of spring *M* until the plunger reaches its lowest position in the opening in *B*, whereupon the fingers close in against the body of plunger *F* and seat over the edge of shell *G*. The upward movement of the plunger causes the shell to be stripped from the plunger by the fingers. This operation is so successful that, no matter how rapidly the machine operates, the shells are stripped from the plunger, thus eliminating the necessity of discontinuing the operation of the machine periodically to regrind the flange of die *B*.

The inner ends of the stripping fingers *K* and *L* may be shaped to conform to the shape of the shell being formed, different shapes being shown in Fig. 1. The spiral spring *M* is formed into a ring by connecting the opposite ends as shown. At intervals, screws are threaded into the side of base *A* which hold the spring in the proper position. Any number of stripping fingers may be used; however, from practical experience the writer has found that two opposing fingers are sufficient for any ordinary work of this kind. It has been found that the particular resilient means described is a most satisfactory one for producing the inward movement of the stripping finger. However, the device may be provided with a band or a leaf spring, secured to the base through which the fingers project.

DOUBLE-SPINDLE MILLING MACHINE FOR WRENCH SLOT IN DETONATOR SOCKET

BY DONALD A. BAKER[1]

The manufacture of fuse parts, which calls for quantity production, has necessarily brought forth a number of interesting and unusual special machines and devices, among which is the machine shown in Fig. 1. This machine is designed for the purpose of milling the wrench slots *C* in the detonator socket shown at *A* in Fig. 2, which is made from drawn brass rod. The simplicity of this machine and the directness of its action make it possible to machine from four to five thousand of these parts per day. The machine consists primarily of a work-holding member and two cutter-carrying spindles *B*, Fig. 1, with means for driving the spindles and advancing the work to the cutters and a stop to regulate the depth of the cut. For locating and holding the work, a hardened and ground steel plate *C* is provided which has a hole through the center into which the stem of the detonator socket may be passed and which has clearance holes in it through which the cutters *F* pass. This plate is screwed and doweled to the sliding over-arm *D*, the front of which, in addition to being bored out to receive a shoulder on the locating plate, takes a bronze bushing *E*, in which is a clearance hole through which the work passes, and also two holes which act as bearings and steadyrests for the two cutters *F*.

The spindles *B* have spiral gears cut on their inner ends which mesh with each other as shown, while into the end of one of them is screwed an auxiliary spindle *G* which carries a driving pulley *H*. All spindles are hardened, ground, and lapped, the main spindles *B* running in either cast-iron or bronze bearings, while the auxiliary spindle runs in a cast-iron bearing at one end and is supported by a combination radial and thrust ball bearing at the other end. In addition, the driven spindle is provided with a thrust ball bearing behind it, as shown at *J*, the thrust of the spiral driving gear being such as to keep it against this bearing. As a means of feeding the work to the cutters, a finger *K* is provided, attached to the rod *L*, which slides in a suitable bearing in the body of the fixture. The action of this sliding rod is controlled by the spring *M* and the lever *N*, the latter being connected to a foot-treadle on the floor. Besides the sliding motion, a rotary motion is also imparted to this rod by means of a cam path milled in one side of it at *O*, which engages with a teat on the end of the screw *P*; the purpose of this motion will be explained later.

[1]Address: Care of Service Engineering Co., 25 Church St., New York City.

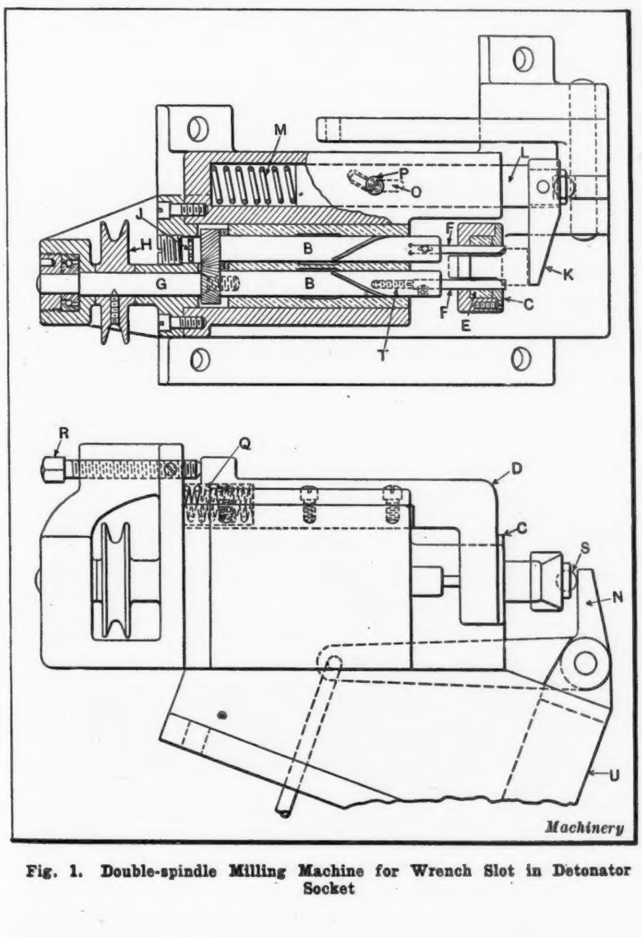


Fig. 1. Double-spindle Milling Machine for Wrench Slot in Detonator Socket

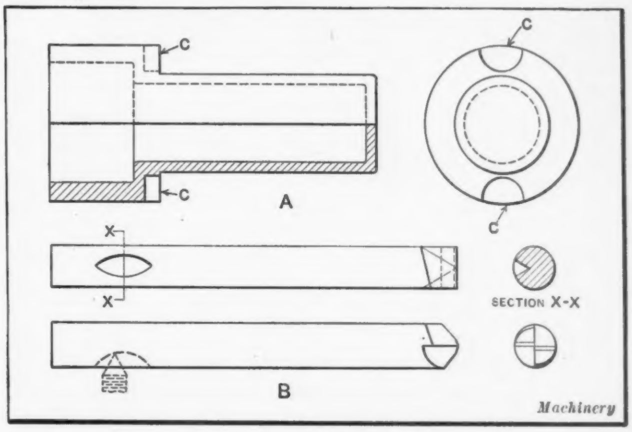


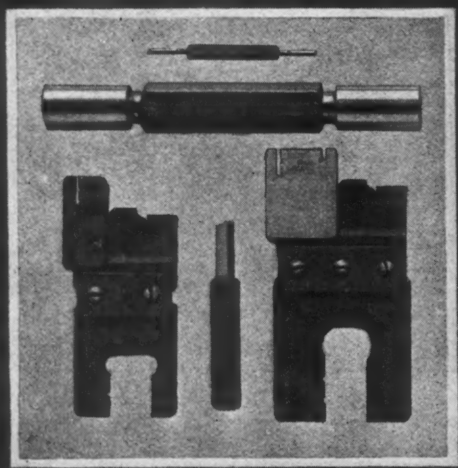
Fig. 2. Detonator Socket and Cutters

The action and operation of the machine is as follows: When the foot-treadle is released, the rod *L* is pushed forward to the right by the spring *M*; through the action of the cam path *O*, the finger *K* is swung down out of the way, which allows a piece of work to be put into position in the locating plate *C*. When in place, as the spindles run continuously, it is only necessary to press on the foot-treadle, pulling lever *N* down; then the finger *K* swings up into position directly behind the work and moves forward, firmly seating the work against the face of the plate *C*, the spring *Q* acting on the end of the slide *D* being sufficiently strong to hold the work against any tendency of the cutter to disturb it. The continued pressure of the finger *K* carries the work forward to the cutters which perform their work, the depth of the cut being taken care of by means of the adjusting screw *R* which strikes against the end of the slide *D*. On releasing the foot-treadle, all parts return to the former position, ready for unloading the finished part and inserting a new one.

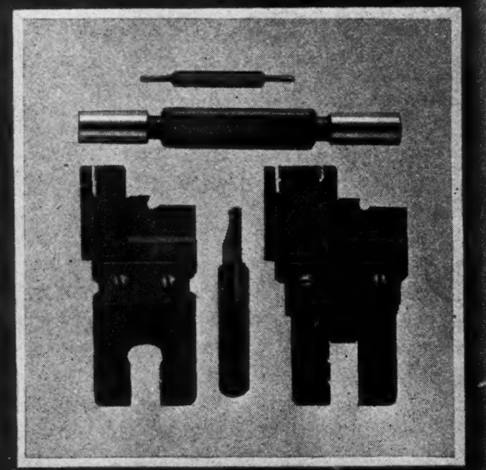
The hardened ball *S* takes the thrust of the lever *N* and allows of a smooth and easy action of the rod *L*. Sight-feed oilers are provided to take care of the lubrication of the main bearings and also to carry lubricant to the cutter-guide bushing *E*. For adjustment of the cutters in relation to each other, one of the spindles is provided with an adjusting screw *T*, placed directly behind the shank of the cutter. The cutters are shown at *B*, Fig. 2. They are carefully made from drill rod, hardened all over, and ground to a uniform length. The speed of the cutter-spindles is about 7000 revolutions per minute. The base of the machine *U* is set on an angle as shown, which makes the machine a little easier to load and unload. The machine as a whole is practically fool-proof, as the operator is only required to put the work in place, operate the foot-treadle, and take the finished work out. Incidentally, the cut is so light and the speed at which the cutters run is so great that it is practically impossible for the machine to be operated too fast.

* * *

A French investigator states that the useful life of a file is, on an average, 25,000 strokes, which is equivalent to two full working days of ten hours each. Files should be discarded as soon as they have passed through the period of useful life, because worn files are expensive to use. It has been estimated that, counting the workman's time and overhead charges, a new file would be capable of turning out a given amount of work at $4.60, which, when using an old file, would cost $10.60.



Snap and Plug Gages



Second of a Series of Articles Describing Principles Involved and Procedure Followed in Developing Gaging Systems for Interchangeable Manufacture—Based upon the Experience and Practice of the Pratt & Whitney Co. in Furnishing Gages for Small Arms and Heavy Ordnance Work

By ERIK OBERG, Editor of MACHINERY

SNAP gages are among the oldest and doubtless the simplest and cheapest of all gages that are used for interchangeable manufacture. As a general rule, they should be used whenever possible, and in nearly all cases where external measurements of diameters or widths of pieces are to be gaged, the snap gage is most easily applied. The earliest form was the "one-size" type; that is, a gage generally of a horseshoe shape, intended to measure or gage the exact dimension to which it was made. Later, the limit gage was introduced, having two steps, one for the maximum and one for the minimum dimension of work for which a certain tolerance had been previously determined. At first, all limit gages were made with solid jaws and with a horseshoe shaped handle or holder, but later adjustable snap gages were introduced having measuring points similar in principle to those of a micrometer, and adjustable within a certain range, so that, if the tolerance were changed on the work, the gage could be easily adapted to the new tolerance; or if the gage points should wear, this wear could be compensated for by an adjustment. Locking means were provided so that, when the gage had been set or adjusted, the measuring points could be positively locked in the required positions. The horseshoe-shaped one-size snap gage, when worn, may also be brought back to size by peening and subsequent lapping of the gaging surfaces, an operation that requires considerable care.

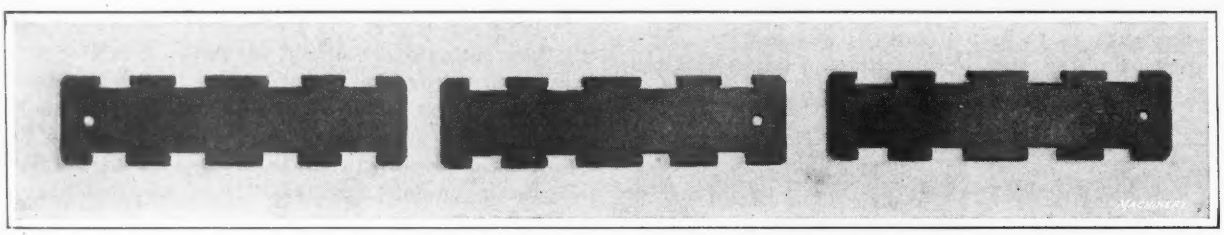


Fig. 1. Snap Gages of the Old Type with too Many Gaging Notches in One Piece

Snap Gages for Small Interchangeable Work

In the case of small interchangeable work, where the quantities made are very large, as in rifle manufacture, it has been found most satisfactory to make the snap gages non-adjustable, as in this case a number of gages may be easily combined into one piece, or held in one holder. The old-fashioned way was to take a flat piece of steel and cut a number of gage slots or openings in it. Gages of this type are shown in Fig. 2, in each of which are combined four

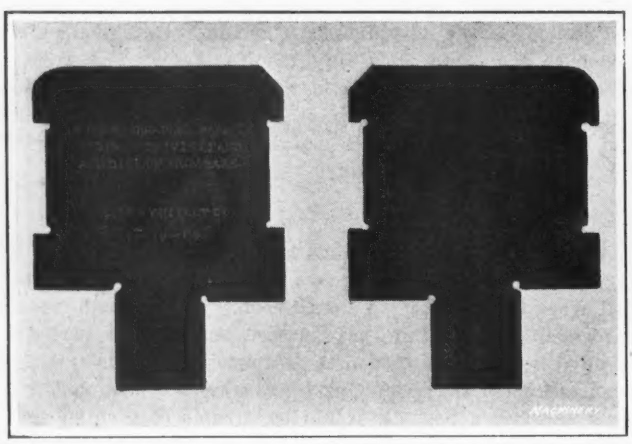


Fig. 2. Another Snap Gage of Old Type in which Various Gaging Notches are cut in One Solid Piece of Steel

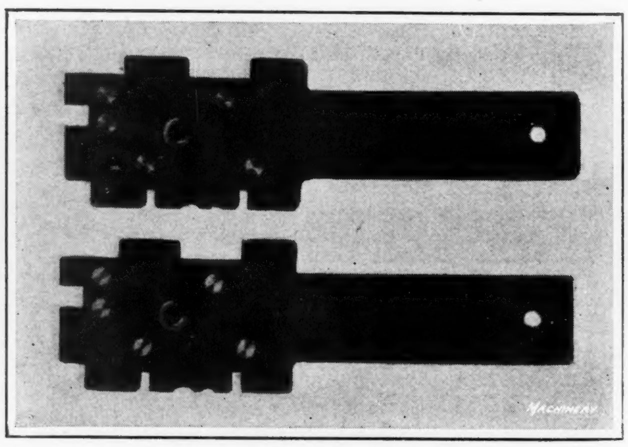


Fig. 3. Improved Type of Snap Gage in which Blocks or Filler Pieces are used in the Gaging Notches to take Care of Wear or Changes

gage sizes. Of the two gages shown, one is the inspection gage and the other the working gage. Fig. 1 shows an example of a gage containing eight gaging slots. The advantage of gages having a number of gaging slots is that it makes it unnecessary to use a great number of individual gages; time is saved both in the shop and inspection room, because it is easier to handle one gage than to pick up successively a number of gages; and, furthermore, mistakes are more readily guarded against, as the operator and inspector quickly become used to the positions of the various gage slots in the combination gage, whereas it is more likely that the wrong gage might be used when a great number of individual snap gages are employed. However, the types of gages shown in Figs. 1 and 2 are objectionable, because, where all the snap measurements are cut from one solid piece, if, in making the gage, one gage size is spoiled, the whole gage becomes useless and must be scrapped. Furthermore, if one gaging size becomes worn, the whole gage also becomes useless.

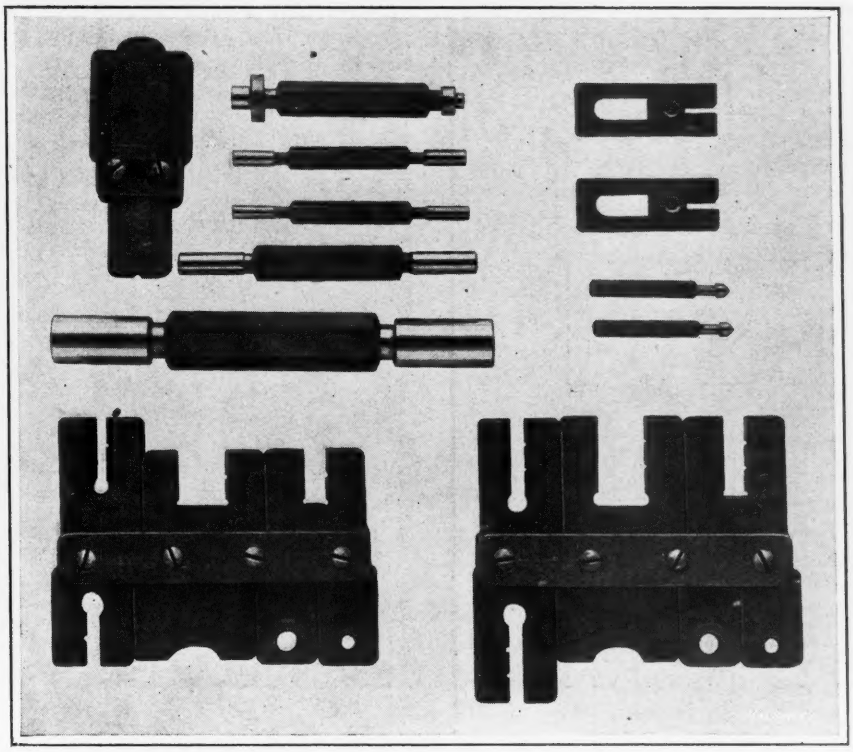


Fig. 4. Complete Gaging Set consisting of Working, Inspection, and Reference Gages, in which the Snap Gages are of the Modern Built-up Type

A method for partially overcoming these defects of the snap gage having a large number of slots or snaps is shown in Fig. 3; as will be seen, blocks or filler pieces are put into the gage openings, the dark piece shown in the gage opening being a detached piece or block of steel. This block is held in place by screws passing through the side of the gage jaw. When worn, the blocks may be packed out by a thin sheet of mica placed between the side of the solid jaw and the block, or an entirely new block may be put into the gage. This method of making a combination snap gage also eliminates any danger of spoiling the whole gage in the making, by a mistake in one gaging size. It also facilitates changing the gage if a change is made in the size or tolerance of the work.

Incidentally, the gage illustrated in Fig. 3 shows the application of small marking disks or buttons driven into the body of the gage and on which the gage sizes are marked. The advantage of using these buttons instead of stamping the sizes directly on the gage as is done in Fig. 2 is that, in case the gage size should be changed, the button may be removed and a new button with the new marking inserted.

Another method for keeping together snap gages that are generally used at the same time is to put a number of individual snap gages on a ring similar to a key-ring. In this way, all the snap gages that belong to one piece or operation may be kept together without having all the gage sizes cut in one solid piece of steel.

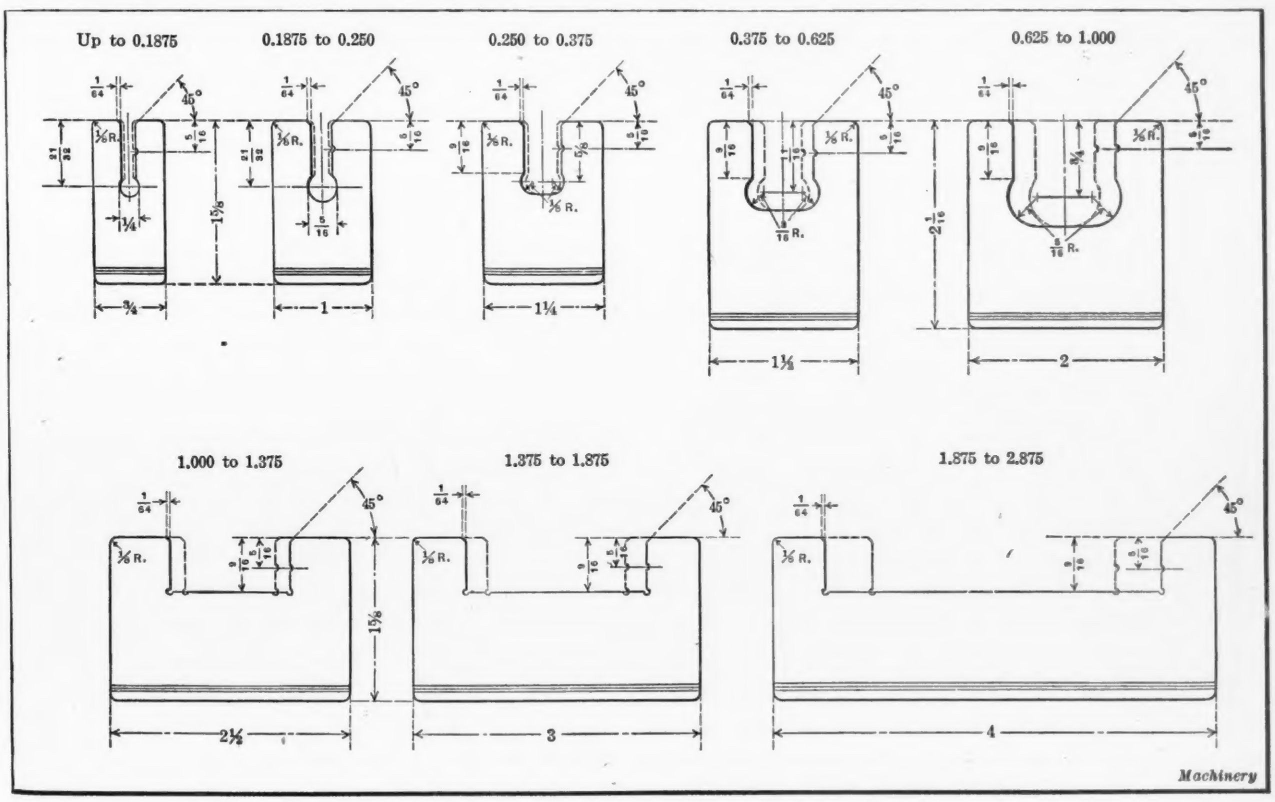


Fig. 5. Standard Snap Gage Blanks used by the Pratt & Whitney Co.

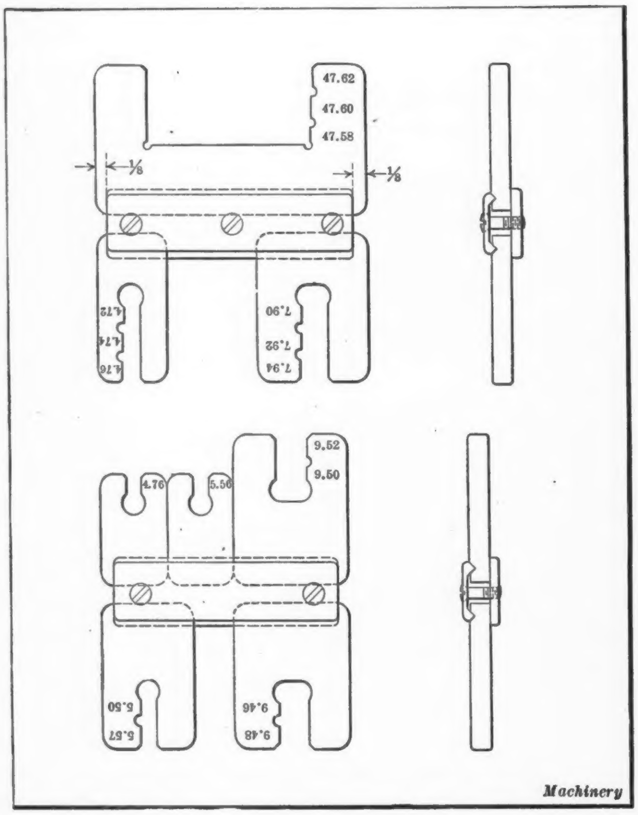


Fig. 6. Method of building up Snap Gages by Means of Clamping Strip and Screws

Built-up Snap Gages

The latest development in snap gage construction is embodied in the built-up snap gage, an example of which is shown in Fig. 4. Here the snap gages are made in individual pieces of steel which are afterward assembled into convenient units, held together by a clamping strip and screws as shown. This type of gage combines the advantages of the types previously described, and eliminates the disadvantages. All the gages for one operation are combined in one holder, but if one gage size is spoiled during

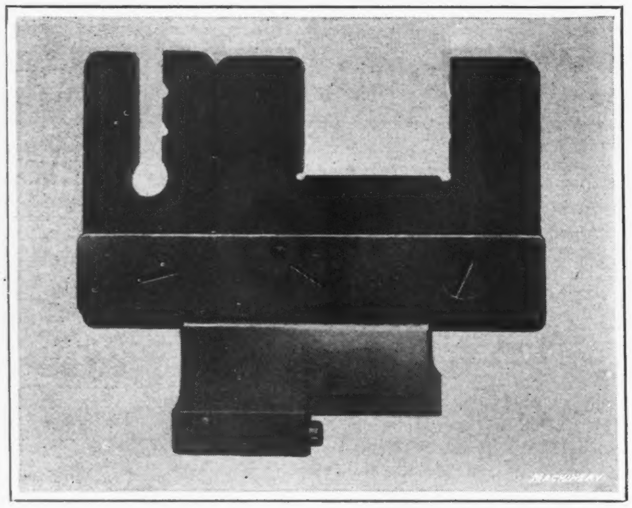


Fig. 7. Example of a Built-up Gage which combines a Flush-pin Gage with Snap Gages

the making of the gage or changed after the gage has been put in use, or if the gage becomes worn, the particular gage affected can easily be replaced by another without changing the other gages in the set. Should the order of operations be changed, it is easy to rearrange the gages in the various holders, as they may be removed and replaced at will and arranged in any required combination. As indicated in Fig. 4, not only snap gages but also ring gages, profile gages, and other types of gages can be combined in one holder, so that all the gages for one operation may be held in the same holder, provided, of course, that they are of such kind and type that they can be made from flat pieces of steel. Gages made in this manner are much cheaper than those made from solid blocks of steel, because the strips, screws, and blanks may be standardized and kept in stock. A set of gage blanks which covers a range from the smallest size up to snap sizes of 2⅞ inches is shown in Fig. 5, this being a standard line of blanks used by the Pratt & Whitney Co. Fig. 6 shows the construction of the built-up gage in detail, indicating how the clamping strips are made and how the blanks are held by it. It will be noted that there is a V-groove on the top of the gage blanks into which

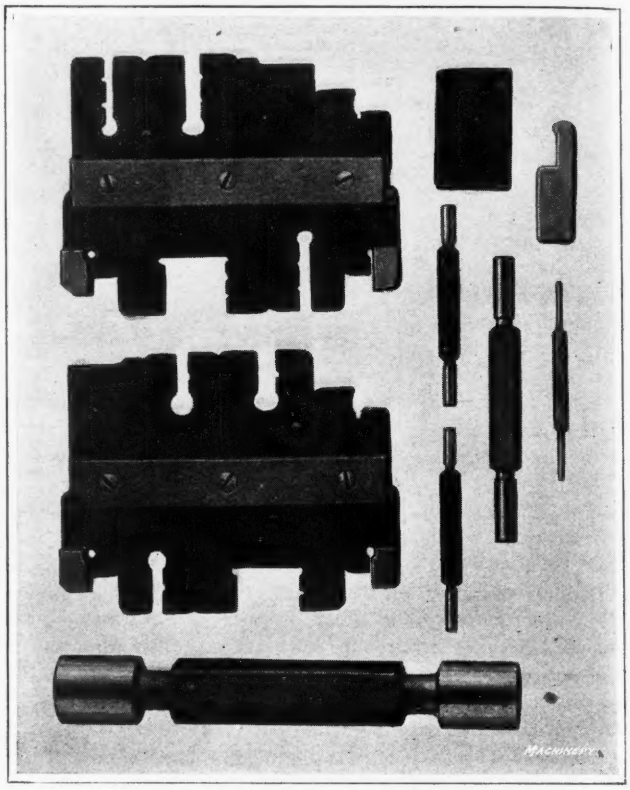


Fig. 8. Complete Set of Working, Inspection, and Reference Gages showing how Different Types of Gages may be combined by the Built-up Gage Principle

a V-projection of the upper clamping strip fits, thus holding the blanks firmly in place. It will be noted that at the snap opening, the edges are beveled off to a 45-degree angle; the object of this is to permit the work to enter the gage easily. In some cases, the edge is rounded instead of being beveled.

In Fig. 4 is shown a complete set of gages for one operation. In the lower right-hand corner are shown the working gages which have three steps in the limit snap gages—maximum, mean, and minimum. To the left are shown the inspection gages which have only two steps for maximum and minimum dimensions. The plug gages at the top are the reference gages. This illustration, therefore, shows a

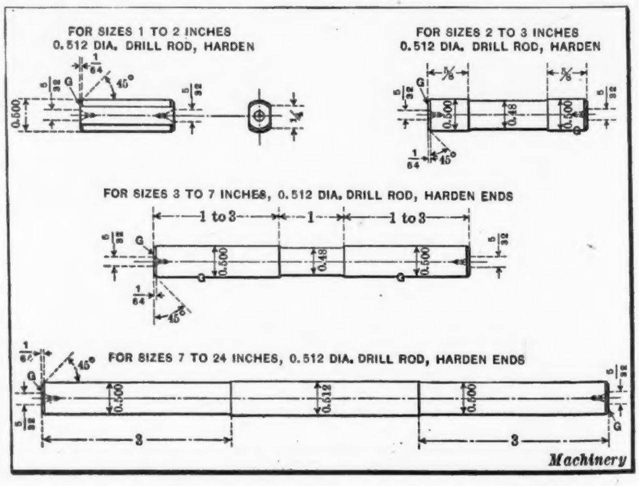


Fig. 9. Standard End-measuring Rods used by the Pratt & Whitney Co.

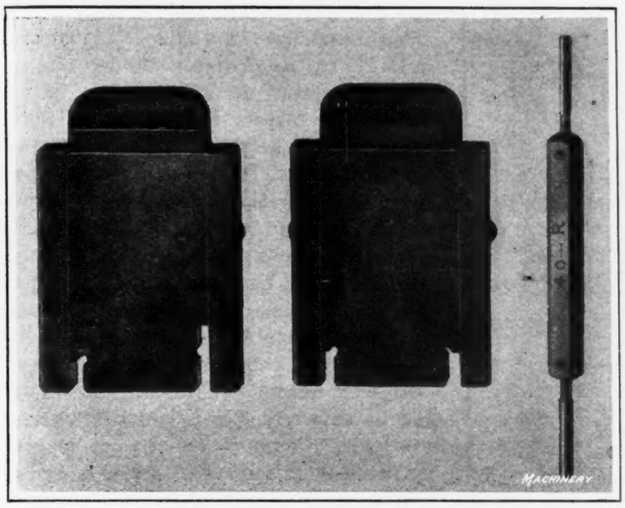


Fig. 10. Snap Gage made by attaching Strips to Sides of Blank

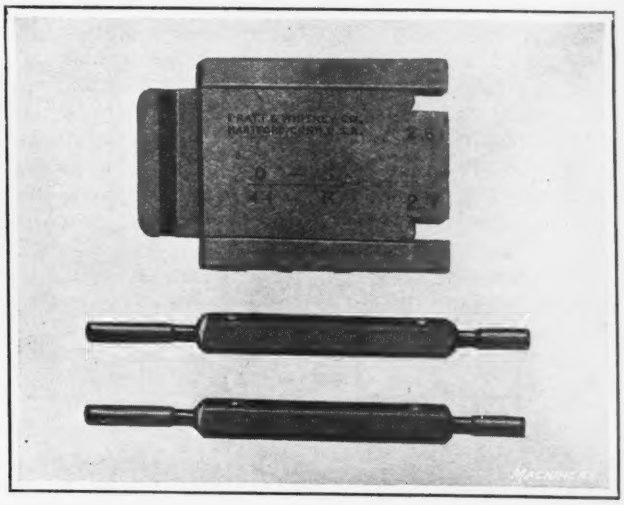


Fig. 11. Reference Gage made by Strips attached to Sides of Blank

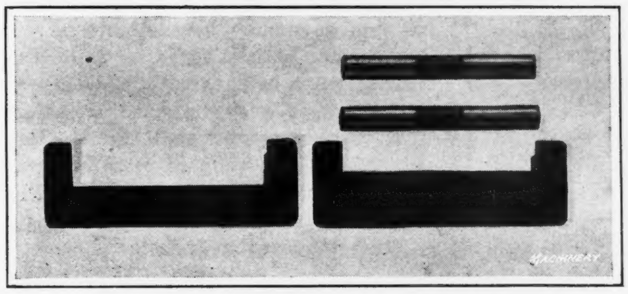


Fig. 12. End-measuring Rods used as Reference Gages

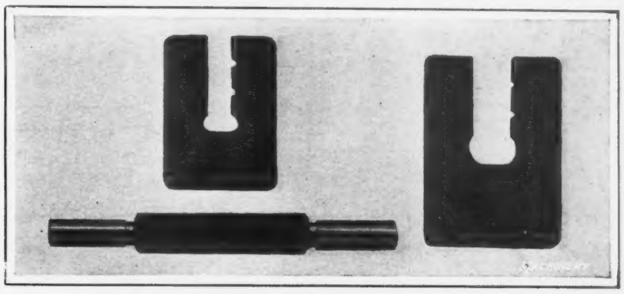


Fig. 13. Snap- Gages used independently and not held in a Holder

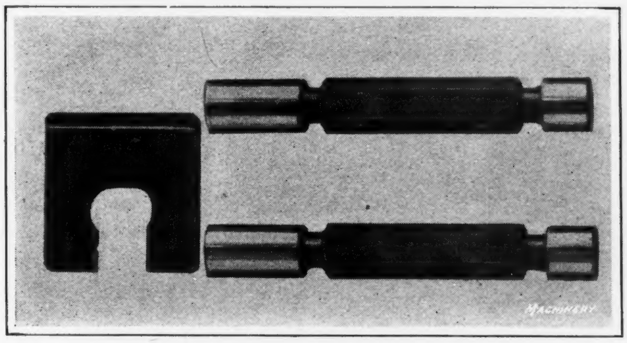


Fig. 14. Working and Inspection Plug Gages with Reference Snap Gage

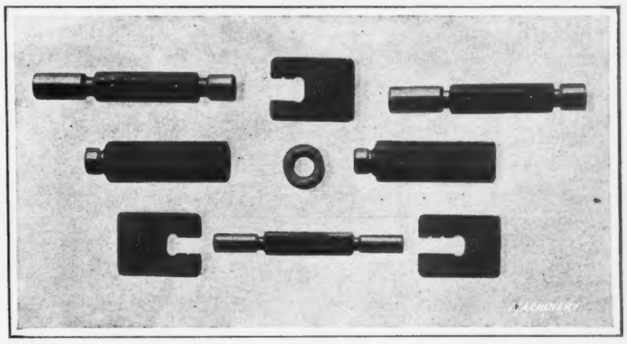


Fig. 15. Set of Gages showing Both Snap and Ring Reference Gage

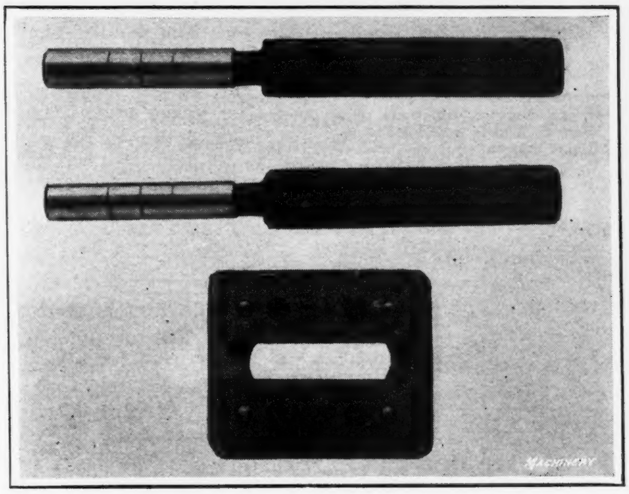


Fig. 16. Taper Plug Gage with Reference Gage, for Cylindrical Holes

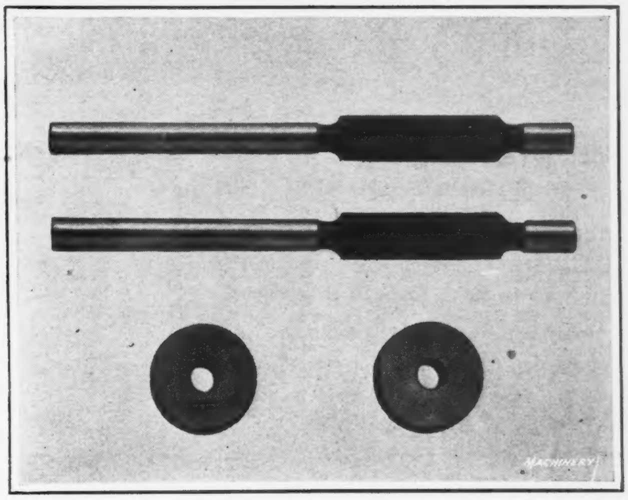


Fig. 17. Long "Go" Plug Gage used for Rifle Barrels

complete set of working, inspection, and reference gages such as would be furnished for interchangeable manufacture. When the snap gage dimensions are comparatively small, plug gages are used as reference gages, but when the snap dimensions are large, end-measuring rods are used as references for the inspection gages, as indicated in Fig. 12. This illustration shows to the left the three-step working gage and to the right, the two-step inspection gage, together with the maximum and minimum reference end-measuring rods.

Reference Gages for Snap Gages

Cylindrical plug gages, as shown in Fig. 4, are generally preferred as reference gages for snap gages of smaller sizes. Flat plug gages are sometimes used, but are not recom-

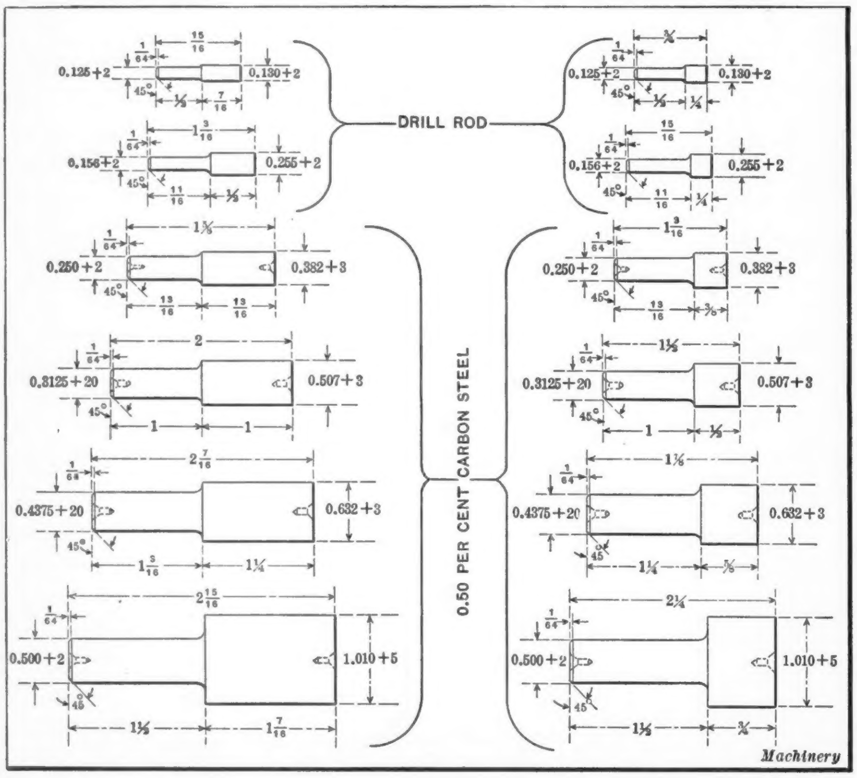


Fig. 18. Standard Plug Gage Blanks for Limit Gages used by the Pratt & Whitney Co.

mended, because it is easier to determine wear with a cylindrical plug gage, as there is a line contact between the plug and the surface of the snap gage. For smaller sizes, the cylindrical plug gage is cheaper to make, while, for the larger sizes, the end-measures are cheaper, it being evident that it is out of the question to use plugs as reference gages for very large dimensions. Standard blanks are kept in stock for these end-measures, a line of Pratt & Whitney standards being shown in Fig. 9. These end-measures are made from round stock, because it is cheaper to make them in this way.

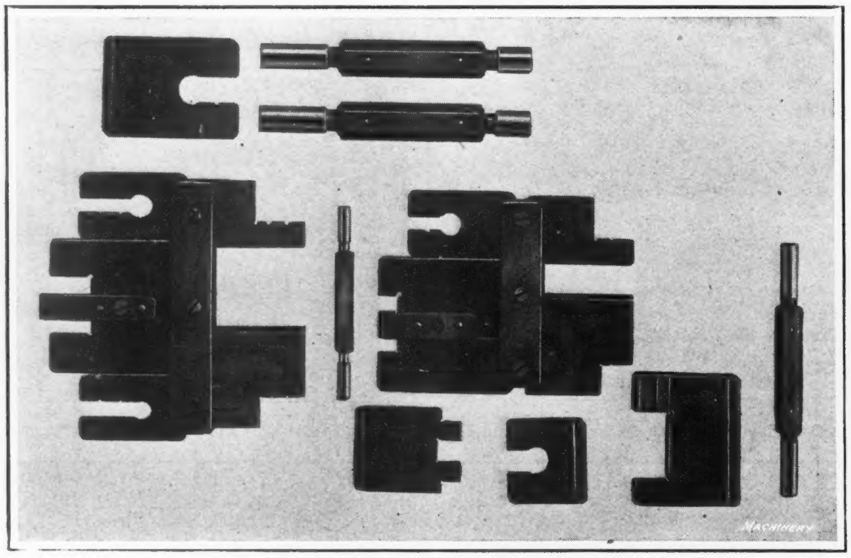


Fig. 19. Complete Set of Working, Inspection, and Reference Gages in which are shown Working and Inspection Plug Gages with Ends of Unequal Length and Reference Plug Gages with Ends of Equal Length

Modifications in Making Snap Gages

In Fig. 10 is shown a special construction of a snap gage to be used in standard holding strips, as indicated in Figs. 4 and 6. Here the gage slot is very narrow and, therefore, a strip is screwed onto the side of the standard gage blank and the gage measurement is taken between this strip and the side of a notch cut into the corner of the gage blank. The object of this construction is to facilitate the grinding of the gage surfaces; it is used when the gage size is 1/8 inch or less. In this case, the working gage is shown to the left, the inspection gage in the middle, and the reference gage to the right. The working gage has the mean step to the left and the maximum and minimum steps to the right. The inspection gage has the maximum step to the right and the minimum step to the left. The reason that the two or three steps are not combined in one slot is to avoid the very deep cut that would then be necessary. Fig. 11 illustrates another example of the same construction of gage, except that the snap gage is the reference gage and the plug gages are working and inspection gages.

Another example of the built-up type of gage is shown in Fig. 8, which illustrates how many different types of gages may be combined in this manner, and also shows what constitutes a complete set of working, inspection, and reference gages for a given operation. Fig. 7 shows how a flush-pin gage may be combined in the same holder with snap gages, indicating the flexibility of the built-up system of holding gages with standard strips. It is evident, of course, that the standard gage blanks can be used without being held in a holder, as indicated in Fig. 13, where individual gages are shown made up from standard gage blanks, but not used in combination with other gages or held in a holder.

Plug Gages

The Pratt & Whitney Co.'s practice in making plug gages for interchangeable manufacture is to use standard plug gage blanks as shown in Fig. 18, and from these blanks any sizes that are required are made. The blanks shown to the left have a longer gaging surface than those shown to the right

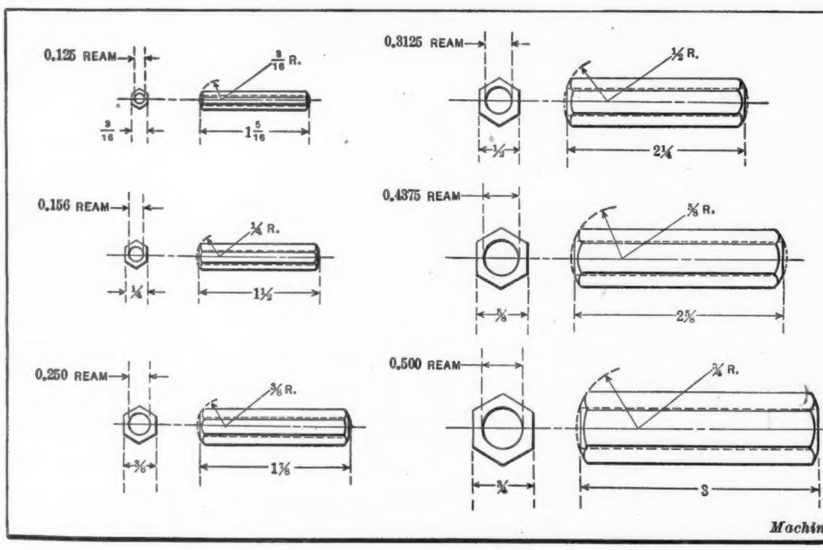


Fig. 20. Hexagon Handles used for Limit Plug Gages

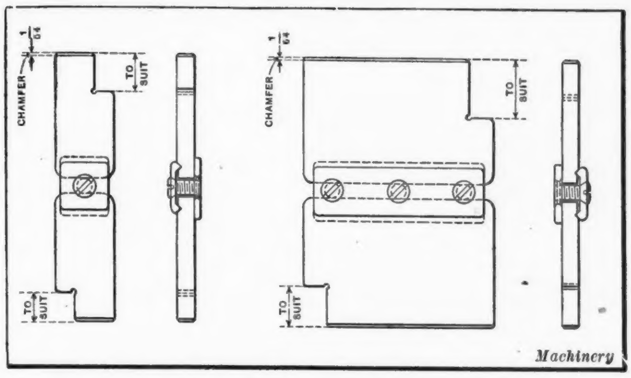


Fig. 21. Flat Plug Gages of the Built-up Type

and are intended either for the "Go" size in a working or inspection gage or for the "Go" and "Not Go" sizes of a reference gage. The blanks shown to the right, having a shorter gaging surface, are intended for the "Not Go" ends of working and inspection gages. In Fig. 20 are shown the standard hexagon handles that are used for holding the plug gage ends, the "Go" size being inserted at one end of the handle and the "Not Go" at the other. It is evident that it is both cheaper and more convenient to make gages in this manner. By using hexagon stock for the handles, the gage may be laid on the bench or table without rolling off. Another advantage of the hexagon handle is that it is easier to stamp the gage dimensions on it, as it has a better place for marking than would a round handle which, if knurled, would have to be provided with a milled flat for marking. The hexagon handle is also easier on the user's hand.

It is evident that, by having the two limit gages inserted one in each end of the handle, repairs or changes are greatly facilitated, as if only one end is defective only one gage

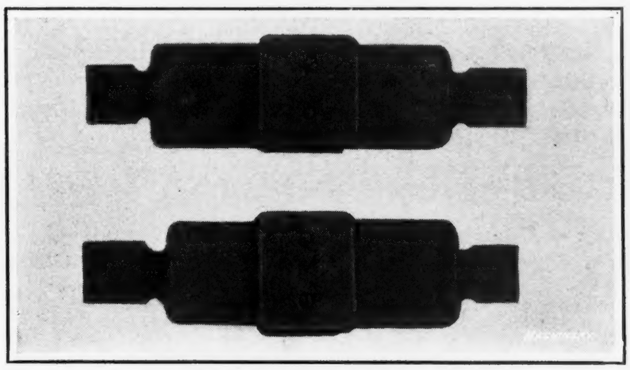


Fig. 22. Another Example of Flat Plug Gages of the Built-up Type

needs to be scrapped. As the "Not Go" gage does not wear out as soon as the "Go" gage, generally the former only need be replaced when worn. Also, in case the tolerance should be changed, it is likely that only one of the gages need be replaced, and in any case the handle is saved.

The gages are pinned in place in the handles by taper pins, the shanks of the gages being straight. The hexagon handles are made from low-carbon machine steel, while the gages are made from drill rod for the sizes up to and including 1/4 inch, and from 0.50 per cent carbon steel for larger sizes.

Fig. 19 shows a set of plug and snap gages. The two plug gages at the top are working and inspection gages having the "Go" ends longer than the "Not Go" ends. The two plug gages shown in the lower part of the illustration are reference gages in which the plugs at both ends of the gage are of equal length. The reference gages are often made with long necks so that they will reach down into the snap gage slots when these consist of three steps.

Referring again to Fig. 19, it will be noted that the reference gage for the plug gages is a snap gage, as shown in the upper left-hand corner. A snap gage is cheaper and simpler to make as a reference gage for a plug gage than would be a ring gage, and as a plug is not likely to be out of round, the snap gage is generally as satisfactory as a ring gage.

Fig. 14 shows a simple set of working and inspection plug gages with a reference snap gage. Fig. 15, again, shows an example of working and inspection plug gages with a snap reference gage at the top, while in the middle is shown an example of plug gages having a ring reference gage. The reason for using the ring reference gage in this case is that the plug gages measure the depth as well as the diameter of a hole, and a ring reference, of correct length, checks both of these dimensions. At the bottom are shown working and inspection snap gages with a reference plug gage. It will be noted that the reference gage has an equal length of plugs at each end, while the lengths of the "Go" and "Not Go" ends of the working and inspection gages in the upper part of the illustration are unequal, as already mentioned.

Special Types of Plug Gages

Sometimes plug gages are provided with two concentric steps of different diameters in order to enable the concen-

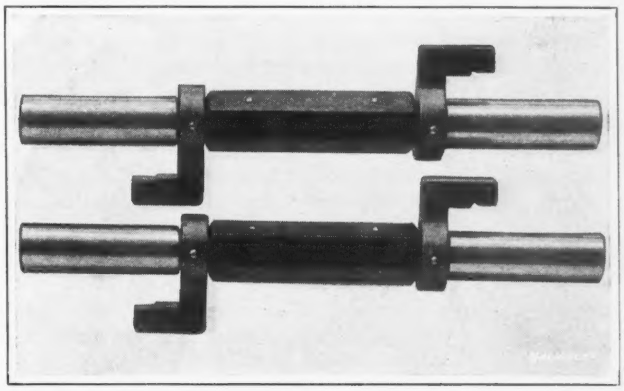


Fig. 23. Combination Plug and Snap Gage used for gaging Holes and Hubs

tricity of two holes to be gaged. Again, a tapered plug gage may occasionally be used for gaging cylindrical holes. In that case, the gage is provided with lines, as shown in Fig. 16, that indicate the maximum and minimum dimension, and sometimes, as in the illustration referred to, the mean dimension. The gage in the lower part of the illustration is the reference gage for this tapered plug gage. The reference gage is also provided with three lines which must coincide with the three lines on the working and inspection gages. Gages of this type are used for special cases only, as a taper gage, of course, does not indicate that the hole is straight nor that it is not tapered, but merely shows the size at the end. The gage shown is used in drilling gun barrels to indicate definitely how near to the exact size the barrel is. Fig. 17 shows long straight plugs that are also used for gaging gun barrels. The tapered gage, it will be seen, therefore, is simply an auxiliary gage used in connection with the regular plug gages. The "Go" ends of the plug gages in Fig. 17 are very long, in order that they may indicate the straightness

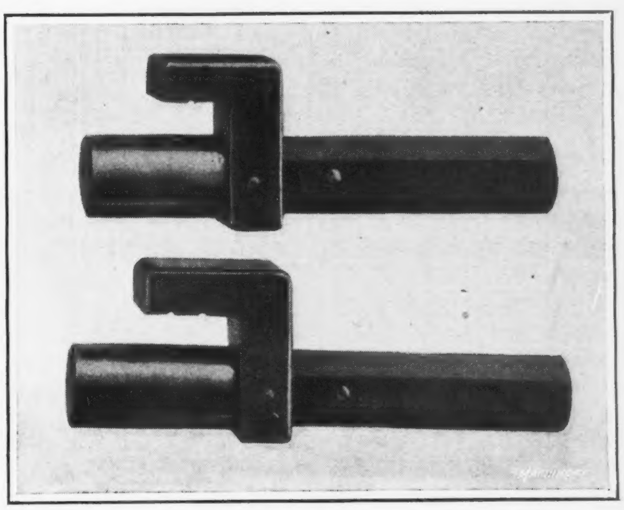


Fig. 24. Another Combination Plug and Snap Gage in which the Working Gage is provided with Three Steps

of the barrel for a considerable distance. In this case, ring reference gages are used for the plug gages instead of snap gages, as is the usual practice.

Flat Plug Gages

Plug gages made from a flat piece of steel instead of from cylindrical stock are sometimes used, especially for measuring the width of slots, as they provide for greater wear than cylindrical plug gages, the flat plug gage having a surface contact and, hence, greater wearing surface. These flat plug gages are generally made from the regular snap gage blanks, as indicated in Fig. 21, where flat plug gages are shown held by strips and screws the same as regular snap gages. Fig. 22 shows a modification of this type of gage which is used for gaging the length of slots or splines having round ends. In this case, the edges of the gage are rounded so that there is a line contact with the ends of the spline. It is evident that a plug gage with flat edges could not be used.

Combination Plug and Snap Gages

Fig. 23 shows a combination plug and snap gage which may be used for gaging the diameter of a hole and at the same time measuring the distance of a projection from a hole or the concentricity of a hub with a hole. The gage shown in Fig. 23 is double-ended, having limit gages at each end and being used for two hubs. The upper one of the gages is the working gage, while the lower one is the inspection gage. Fig. 24 shows a similar type of gage, but this is used for one hub only, and, therefore, is single-ended. The gage at the bottom is the working gage, which has three steps—maximum, mean, and minimum. The one at the top is the inspection gage which has only maximum and minimum steps.

In following articles in this series, thread gages, contour gages, and miscellaneous gages will be dealt with.

* * *

AREA OF FILLETS

BY HARRY GWINNER[1]

The area of any fillet may be easily determined by means of the chart shown in Fig. 1. As the radius and angle of the

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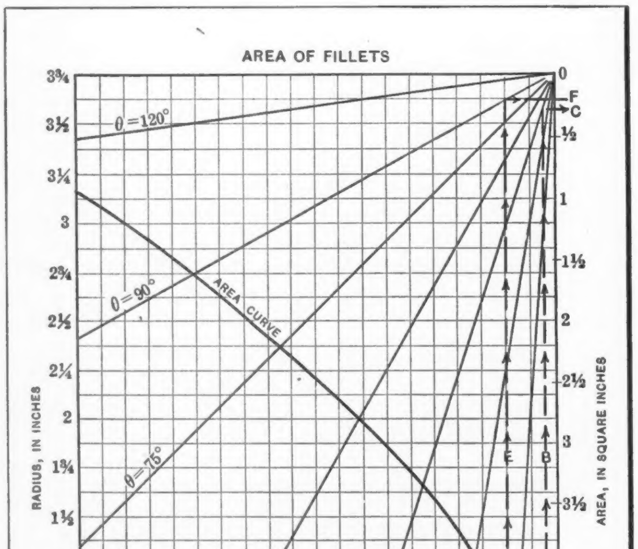

Fig. 1. Chart for determining Area of Fillets

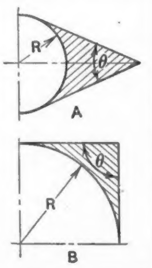

Fig. 2. Fillets of a Common Type

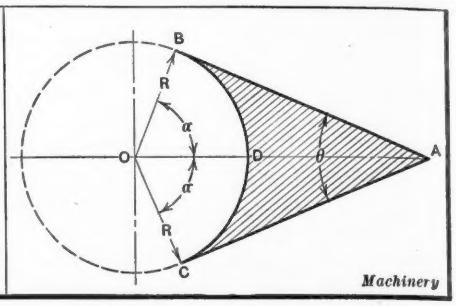

Fig. 3. Diagram used in Analytic Determination of Area of Fillet

fillet are known, to find the area pass a horizontal line through the number on the left-hand edge corresponding to the given radius until it intersects the area curve; at this point of intersection erect a perpendicular that will intersect the line representing the angle of the fillet, and from this point draw a horizontal line to the right-hand edge of the chart. The intersection of this line with the edge of the chart gives the area desired. For instance, for the fillet shown at *A*, Fig. 2, if the radius is ½ inch and the angle θ is 45 degrees, a horizontal line *A* is drawn from ½ on the left-hand edge of the chart, Fig. 1, to the area curve. Then a perpendicular *B* is erected until it intersects the 45-degree line. A horizontal line *C*, drawn from this point of intersection with the right-hand edge, shows that the area of this fillet is approximately 0.3 square inch. If the radius of the fillet shown at *B*, Fig. 2, is 1 inch and the angle θ is 90 degrees, a horizontal line *D* is drawn from 1 on the left-hand edge to the area curve, at which point of intersection a perpendicular *E* is erected until it intersects the 90-degree line; then a horizontal line drawn from this point to the right-hand edge shows that the area of this fillet is approximately 0.21 square inch.

The formula for the analytic check is as follows: Let *ABDC*, Fig. 3, be the given fillet and θ the angle between the sides, which by the conditions are tangent to the arc. Then angle $BOA = COA = \alpha =$ complement of $1/2\ \theta$. R is radius of circle. As $AB = R \tan \alpha$, the area of the triangle $OAB = \frac{1}{2}(R \times R \tan \alpha) = \frac{R^2}{2} \tan \alpha$, and the area of $OBAC = 2 \times \frac{R^2}{2} \tan \alpha = R^2 \tan \alpha$. As the arc $BC = 2R\alpha$ (in radians), the area of the sector $OBDC = R^2\alpha$ and the required area $ABDC = R^2 \tan \alpha - R^2\alpha = R^2 (\tan \alpha - \alpha)$.

* * *

According to a report of the Technical Department, Aircraft Production, British Ministry of Munitions, the aluminum pistons used by the Germans in the 230 horsepower Benz airplane engine weigh 4 pounds 8½ ounces, without the rings. With the rings and gudgeon pin set-screw, the piston weighs 4 pounds 16½ ounces, or 1 pound 13 ounces less than the standard cast-iron piston. The rings, which are of cast iron, have an exceptionally wide gap and are very deep in section. They are all concentric and are machine-hammered on the inside. Three are placed above the gudgeon pin and the scrape ring is placed below. The dome head of the piston is reinforced by eight webs, which radiate from a common center like the spokes of a wheel. These webs are not used in the cast-iron pistons in the engines of the same type. An analysis shows that the metal of the piston contains 80.12 per cent aluminum, 6.02 per cent copper, 12.13 per cent zinc, 1.42 per cent iron, 0.31 per cent silicon, and traces of manganese and magnesium. This metal is very hard and has no elongation. It was no doubt intended to approximate the physical qualities of cast iron; otherwise the content of copper would probably have been lower.

* * *

The development of the steel industry in Australia is indicated by the report that an Australian steel company, besides sending munition steel to Great Britain, has supplied South Africa with 20,000,000 tons of steel rails.

ALUMINUM AND COPPER ALLOYS

FIELD FOR THESE ALLOYS AND DIFFICULTIES MET WITH IN THEIR MANUFACTURE

BY CHARLES VICKERS[1]

THE first conception of aluminum bronze was that of a copper and aluminum alloy that must contain the least possible amount of impurities. According to Brannt, great attention should be paid to the quality of the copper, as such impurities as antimony, arsenic, and iron were claimed by him to impair the quality of the bronze; he also stated that an aluminum with as small a percentage of iron as possible should be used, but the silicon in commercial aluminum was not so harmful, although it did harden the bronze considerably and increased its tensile strength. Modern research has shown the facts in the case to be materially different. Iron, instead of being injurious, is more beneficial than any other known element and least injurious when used in quantity. Arsenic and antimony are both very injurious, and for this reason electrolytic copper must be used in making aluminum bronze. The aluminum should also be as free from silicon as possible.

The theory that iron is harmful to aluminum bronze has probably retarded the discovery and consequent utilization of aluminum and copper alloys and has stood in the way of the commercial development of aluminum bronze for many years. The idea, no doubt, was largely based on the prejudice of all brass casters against iron, due to the fact that iron fails to remain in solution with the copper-tin series of alloys or with copper, zinc, tin, and lead mixtures, but segregates in the form of intensely hard nodules of steel. This segregation of iron in certain copper alloys is probably due to the absorption of carbon by the iron and to the fact that it is too tightly held to be easily separated therefrom. Copper has no such affinity for carbon as iron and some other metals, for, instance, nickel; therefore, it is unable to assimilate the combination of iron and carbon and possesses no power to separate them, combining with the one and rejecting the other. The consequence is that iron carbide, having no affinity for the copper or alloy of copper and a much higher melting point, separates as small pellets scattered throughout the brass, thus causing much trouble for the machinist.

When the iron is carbon free, it will alloy with the copper at the proper temperature. Thus, in making alloys of iron and copper alone, it is necessary to use iron as free from carbon as possible and to prevent the introduction of carbon while melting. If copper and cast iron are melted together, no matter how vigorously the mass is stirred, the metals will separate upon solidification. It is evident, therefore, that carbon is the disturbing element when making alloys of copper and iron; and as carbon is always present in brass-foundry melting operations, if brass chips are melted, for instance, and the iron is not removed before the operation, the copper has an excellent opportunity to combine with carbon so that nodules are found in the castings.

Effect of Aluminum on Iron and Copper Mixtures

Aluminum freely alloys with copper in all proportions; it will also alloy with iron, and when added to a liquid mixture of iron and copper it will cause the two to combine, regardless of the presence of carbon. It is immaterial whether wrought iron or cast iron is used in making aluminum bronzes containing iron, because, after the aluminum has been added, the carbon will be ejected from the iron. Wrought iron is probably more convenient to use than cast iron, because little, if any, allowance need be made for loss due to ejected impurities. When cast iron is used, the carbon is ejected by the aluminum and floats to the surface of the molten alloy as a finely divided flocculent mass, which can be skimmed off. It is necessary to use more iron in order to make up this loss. In some instances, where the furnace temperature is low, it is more convenient to use cast iron in making alloys of copper and aluminum containing considerable percentages of iron. The cast iron and copper are melted together with due allowance for loss of weight by the elimination of carbon, and the aluminum is added in small pieces. After each addition, a certain amount of carbon is ejected from the mixture; but if the metal is skimmed each time, the quantity of ejected carbon grows progressively less until it is all eliminated. There appears to be a definite ratio between the weight of the cast iron and the amount of aluminum necessary to eliminate the carbon. In several experiments made by the writer, it appeared that if 20 per cent cast iron was melted with 65 per cent copper, it would require 15 per cent aluminum to eliminate the carbon and to produce a homogeneous alloy of copper, iron, and aluminum. There are many interesting features connected with the elimination of carbon from cast iron by means of aluminum and copper which will afford a fertile field for research.

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TABLE 1. PHYSICAL PROPERTIES OF 10 PER CENT ALUMINUM BRONZE

Number of Bar	Elastic Limit, Pounds per Square Inch	Tensile Strength, Pounds per Square Inch	Elongation in 2 Inches, Per Cent
1	27,410	55,510	4.0
2	22,560	55,900	8.0
3	24,730	37,720	10.5
4	20,610	59,790	17.0
5	19,690	53,700	3.5
6	23,170	40,410	11.5
7	20,870	47,870	5.0
8	21,570	42,800	6.0
9	20,167	48,270	11.0
10	19,720	45,670	4.5
11	20,680	54,150	5.5
12	23,120	58,500	2.0

Machinery

As aluminum promotes the alloying action of iron and copper, the difficulties met with when forming alloys of copper, tin, and iron, or copper, zinc, and iron do not exist when alloying copper, aluminum, and iron. The alloys are easily made and, when machined, appear to be free from the segregation of iron. The objections, therefore, that apply to the use of iron in ordinary brass or bronze do not apply to aluminum bronze; thus there is no good reason why these elements should not be alloyed together. The physical properties of the bronze are improved by small additions of iron, but larger amounts produce an entirely new and greatly superior class of alloys, some of which are being utilized with success in the manufacture of the larger airplanes.

Ten Per Cent Aluminum Bronze

There has been much misrepresentation regarding the physical properties of aluminum bronze. One authority states that the 10 per cent bronze has a tensile strength of about 100,000 pounds and a compressive strength of 130,000 pounds per square inch, while its ductility and toughness are such that it does not even crack when distorted by this load; it is so ductile and malleable that it can be drawn down under a hammer to the fineness of a cambric needle; it works well, casts well, holds a fine surface under the tool, and, when exposed to the weather, is in every respect one of the best bronzes known. As a matter of fact, the strength and ductility of the binary alloy of aluminum and copper containing 10 per cent aluminum is very uncertain, as it is dependent on so many variables. When made under the

most favorable circumstances and with the utmost care, however, the tensile strength will rarely reach 70,000 pounds per square inch and never 100,000 pounds per square inch; it may be considered a well made alloy if its tensile strength is above 60,000 pounds. The elongation varies greatly, and may be from 18 to 40 per cent in well made alloys. The results given in Table 1 are interesting, as they are typical of what may be expected in ordinary practice, that is, if the work is not handled with more than average skill. The reason the physical properties of these alloys were so low was probably because of the presence of some little impurity in the copper, such as arsenic.

This bronze casts well in that it will run into the molds and fill them up better than the other alloys of copper, but it is the most difficult alloy to convert into castings that the founder encounters. It has caused the loss of many thousands of dollars, and there is much hesitancy on the part of founders to cast it at the present time. The alloy drosses badly and the castings shrink, and when these difficulties have been overcome and apparently good castings sent out, in numberless instances cavities have been opened up inside the casting so that the casting has had to be scrapped. In addition, heavy castings of the 10 per cent aluminum bronze are so affected by the slow cooling incident to their massiveness that their physical properties are invariably disappointing. In small castings, the alloy cools quickly, with the result that the crystals are well defined, as shown by fractured surfaces. The larger and more slowly cooled castings possess a fracture inclined to be vitreous; the crystals have blended and merged and show only as shadowy outlines on the fractured surfaces. Because of this peculiarity, aluminum bronze containing 10 per cent and more aluminum and no iron is not suitable for use in heavy castings where great strength is required, unless the sections have been designed with a full understanding of the effects of slow cooling upon the alloy. It would be extremely dangerous to design a casting from data regarding the physical strength that were obtained from the testing of cast-to-size test bars poured in molds separate from the casting. The results in this case would be entirely too high, even if the test bars were poured from the same heat of metal as the casting. The cause of this disparity is the rate at which the two castings were cooled from the liquid state. The change produced by gradual cooling has been termed by the writer "self-annealing," but it is doubtful if the term exactly fits the case.

Fig. 1. Photomicrograph of 10.5 Per Cent Aluminum Bronze, cast in Graphite Carbon Mold

Relation of Rate of Cooling to Physical Properties of a Casting

The introduction of a small amount of iron into the bronze does not materially affect the tendency of the crystals to become blended by slow cooling; it is necessary to add a large amount. In the case of small castings, self-annealing effects can be reproduced by removing the castings from the molds, when red-hot, and placing them in a heated muffle, where they will cool gradually to the room temperature. By this treatment, small castings have been rendered so brittle as to be easily broken with a hammer. When chilling is resorted to, self-annealing is prevented, because the casting is quickly solidified, but chilling is difficult and sometimes impossible to apply to heavy castings. If the castings are water-cooled from a red heat, they are hardened to a point where it is difficult to machine them, as the bronze can be hardened liked steel but to a different degree. When the bronze is so hardened it loses its ductility, although its tensile strength is increased; therefore, water-cooling of large castings, if resorted to at all, must be carried out with a full knowledge of what it is sought to avoid—on the one hand, excessive hardness and brittleness, and on the other, loss of tensile strength and elongation. The physical properties of a massive casting that is air-cooled will, of course, be better than if the casting is left to cool in the mold, because it will cool more rapidly, but it will still cool too slowly to possess the properties of the separately cast tensile test bars.

A number of carefully carried out experiments made by the writer have shown that the disposition of the feeding risers on the test bars is of considerable importance. In this respect, the alloy resembles aluminum and differs from the copper-tin alloys. In the latter alloys, the rate of cooling is secondary to soundness, which can be obtained in a test bar by attaching it to a heavy mass of metal as a feeder. The test bar and feeder should be laid parallel in the mold and the two connected by a rather heavy gate that extends the entire length of the test bar. Under such conditions, the cooling of the bar is retarded by the mass of metal lying beside it, and to which it is connected. This mass of metal insures soundness in the test bar; the highest physical properties of the copper-tin alloys are realized by this treatment. In the case of aluminum bronze, the slow cooling induced by the mass of metal in the feeder outweighs any consideration of soundness; therefore, although the test bar will be sound, its physical properties will be lower than those of bars cast from the same heat and cooled more rapidly, even if the latter have a slightly unsound spot at the center. To obtain the best results from test bars of aluminum bronze, it is necessary to attach the feeders to either end of the grips so that the center will cool rapidly. In all cases, therefore, where it is important that the physical properties of aluminum bronze be known, the test bars should be attached to the castings in such a manner that they will cool at the same rate.

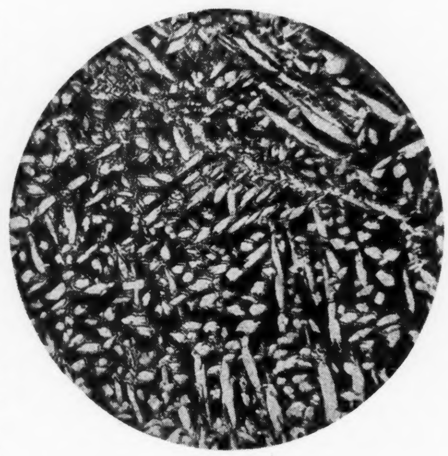

Fig. 2. Photomicrograph of 10.5 Per Cent Aluminum Bronze, cast and allowed to cool in Sand Mold

In the case of a large casting, the process of cooling may be hastened by the intermittent application of water, giving time between each application for the internal heat of the casting to reach the outside. This treatment, however, should not be carried on until the casting has cooled to the room temperature; it is better to discontinue the treatment when the casting has cooled to about 121 degrees C. (250 degrees F.), and allow it to cool in the air.

Heat-treatment of Aluminum Bronze

In the so-called heat-treatment of aluminum bronze, the castings are heated to 900 degrees C. (1652 degrees F.), allowing plenty of time for the heat to soak into the casting. The cold castings, which are hard and possess little ductility, are reheated in a muffle furnace and allowed to cool to the room temperature with the furnace. It is important in the second reheating that the upper temperature limit be kept at 650 degrees C. (1202 degrees F.). The result of this treatment is that the yield point is almost doubled and the elonga-

tion is cut in half, but the tensile strength is not greatly affected. It is rather difficult to apply the treatment commercially and it adds considerably to the expense.

Effect of Mold on Physical Properties of Aluminum-bronze Castings

The specific gravity of an alloy that contains 10.5 per cent aluminum and 89.5 per cent copper, when sand-cast, is 7.43; when chilled by casting in a graphite mold, it is 7.45. The Brinell hardness of the sand-cast alloy is 103, using the 50-kilogram weight, and of the chilled metal, 104. Fig. 1 shows a photomicrograph of the chill-cast specimen magnified about forty diameters, and Fig. 2 the sand-cast alloy. It will be noted that the chilled metal has a closer grain than the more slowly cooled alloy. The effect of rapidly cooling by the medium of the mold on a bronze containing 10 per cent aluminum and 90 per cent copper is shown in Table 2. The graphite mold cools the metal most rapidly, because it has the greatest conductivity; this casting has the greatest strength and elongation. The iron mold cools the alloy a little more slowly than the graphite mold; the carbon mold comes midway between the iron mold and the sand mold; and the sand mold produces the poorest results as to tensile strength and elongation. The distinction between the carbon mold and the graphite mold is that one has been graphitized by the well-known method of heating in the electric furnace, while the other consists of "raw" carbon and, consequently, has a low conductivity.

TABLE 2. EFFECT OF MOLD ON A 10 PER CENT ALUMINUM-BRONZE CASTING

Physical Properties	Graphite Mold	Iron Mold	Carbon Mold	Sand Mold
Elastic limit, pounds per square inch	20,400	20,000	22,000	20,800
Ultimate strength, pounds per square inch	73,800	70,300	62,800	61,100
Elongation in 2 inches, per cent	23.8	21.8	15.0	12.5
Reduction of area, per cent	24.5	25.4	17.8	15.0

Machinery

Effect of Iron on Aluminum-copper Alloys

The introduction of iron into the alloy of aluminum and copper favors more rapid solidification, as the rich iron compound first separates and forms a nucleus around which the crystals are built. The effect of the iron is to form many little centers from which the crystal growth can start; this results in crowding the space available for the growing crystals so that a much finer-grained alloy is produced. The effect of the iron is always to produce stronger, finer-grained metals, hence better alloys. Iron also counteracts the brittleness produced by high aluminum. Thus, an alloy containing 85 per cent copper and 15 per cent aluminum is almost as brittle as glass, but if 12 per cent of the copper is replaced by iron, the very hard alloy produced has important industrial applications. The introduction of about 1 per cent manganese is advisable, as it strengthens the alloy and favors homogeneity. This alloy represents the upper useful limits of both iron and aluminum mixed with copper. Further additions of iron and aluminum fail to increase the hardness of the alloy and tend to produce a silky appearing fracture; the alloy is also weaker. This alloy as cast has a Brinell hardness of 350, using the 3000-kilogram weight, the same as is used for steel. The writer has used this alloy for the dies used in making drawn tubing; many other applications could no doubt be found. This alloy is not patented and may be made by anyone. It contains 70 per cent copper, 3 per cent of 30 per cent manganese-copper, 12 per cent tinplate clippings, and 15 per cent aluminum. It is essential that the full 12 per cent of iron is introduced, but it is advisable to allow more than the 12 per cent of iron to be certain that the bronze contains the required amount; otherwise the brittleness induced by this amount of aluminum in the copper will not be counteracted. This alloy is not subject to self-annealing nor to porosity. It possesses great shrinkage; in fact, the more iron there is added to aluminum bronze, the greater is the shrinkage, but this particular alloy shrinks uniformly, is easily controlled, and causes no trouble from hidden defects. Its tensile strength is about 110,000 pounds per square inch, but it lacks ductility. It is not brittle and has the characteristics of cast iron, but is more difficult to break, owing to its high tensile strength. It possesses great compressive strength and is suitable for use on the turntables of bridges.

An alloy containing about 1 per cent iron and 10 per cent aluminum is largely used for die-casting purposes; because of the increased shrinkage produced by the addition of iron, it is not advisable to go beyond 2 per cent for most die-castings. The physical properties of the latter alloy are considerably better than those of the iron-free metals. The following are typical results: Yield point, 26,000 pounds per square inch; ultimate strength, 76,000 pounds per square inch; elongation in 2 inches, 21 per cent; reduction of area, 19 per cent. By dropping the aluminum to 9.5 per cent, the elongation is increased at the expense of the tensile strength, as shown by the following results, which were obtained from an alloy containing 9.5 per cent aluminum, 1 per cent iron, and the remainder copper: In tension, a yield point of 21,900 pounds per square inch; ultimate strength, 69,800 pounds per square inch; elongation in 2 inches, 39.5 per cent; reduction of area, 35.7 per cent. In compression, an elastic limit of 16,000 pounds, and compression after the application of a load of 100,000 pounds, 18.5 per cent.

This alloy is also subject to the evils of self-annealing. To counteract this trouble, it is necessary to increase the iron over 4 per cent or to introduce zinc, although the addition of the latter impairs the physical properties of the alloy. The effect of self-annealing on alloys containing 10 per cent aluminum and 1 per cent iron is shown by comparing the following results with the last two given. The test coupons were attached to a casting, weighing 100 pounds, that was left to cool in the sand mold; the coupon was cut off the casting and machined to standard size. Yield point, 25,500 pounds per square inch; ultimate strength, 53,100 pounds per square inch; elongation in 2 inches, 8.0 per cent; reduction of area, 11.8 per cent. In compression, the elastic limit was 23,000 pounds and the compression after the application of a load of 100,000 pounds, 13.5 per cent. When zinc was added, the yield point was 29,300 pounds per square inch; ultimate strength, 68,540 pounds per square inch; elongation in 2 inches, 23.7 per cent; reduction of area, 21.5 per cent. In compression, the elastic limit was 20,000 pounds, and the compression after the application of a load of 100,000 pounds, 16 per cent. The fracture was fine-grained and uniform. This alloy consisted of copper, 85.45 per cent; iron, 2 per cent; aluminum, 8.25 per cent; and zinc, 4.30 per cent. The aluminum was lowered to offset the hardening influence of the zinc, and the test bars were attached to a heavy casting to secure the benefit of any possible self-annealing. This alloy is not subject to the phenomena of self-annealing, as far as has been determined. The writer, however, does not advocate the use of zinc in aluminum bronze if it can be avoided.

For heavy castings, the following alloy, which is free from self-annealing, is greatly to be preferred: Copper, 88 per cent; aluminum, 7 per cent; iron, 3 per cent; and manganese, 2 per cent. The manganese is most cheaply and conveniently added in the form of ferro-manganese, the amount of iron so added being deducted from the total iron. The physical properties of this alloy, as determined by two cast-to-size test bars of standard size, made in sand molds are: Yield point, from 25,650 to 26,600 pounds per square inch; ultimate strength, from 74,000 to 74,500 pounds per square inch; elongation in 2 inches, 41.5 to 37.5 per cent; reduction of area, 30.5 to 32.0 per cent. The fractures were sound and uniform, but the external surface of the test bars showed a

little folded-in dross, which undoubtedly lowered their physical properties, but, nevertheless, the physical properties of these bars can be equaled only by bars of well-made manganese bronze.

For small castings where high tensile strength, combined with a fair degree of ductility, is required, the following alloy is recommended: Copper, 83 per cent; iron, 7 per cent; aluminum, 10 per cent. The physical properties of this alloy, as shown by cast-to-size bars made in regular sand molds and using standard tensile bars, are: Yield point, 28,300 pounds per square inch; ultimate strength, 92,500 pounds per square inch; elongation in 2 inches, 19.5 per cent; reduction of area, 21.2 per cent. The alloy makes nice clean castings, and the elongation could probably, with care, be brought much higher, as this alloy was made without any particular attention being paid to the use of suitable fluxes. It is a question, however, if the alloy is subject to self-annealing, as the iron is high, but an alloy containing 4 per cent iron and 10 per cent aluminum is weakened materially by gentle cooling methods.

All alloys of copper and aluminum are greatly improved by double melting, and should be melted twice for important castings; but there is no truth in the oft-repeated statement that aluminum bronze is brittle when made by the simple mixing of the ingredients, and must, therefore, be cast several times. If the alloy on the first melt should be brittle, it indicates that an error has been made in weighing the proportions of the metals, or the alloy has not been stirred after the addition of the aluminum. The bronze should be stirred with a pumping motion, when it will be perfectly alloyed the first time it is made, although it gains in ductility by a second melt.

* * *

CUTTING SCREW THREADS BY A PRIMITIVE METHOD

BY GUY H. GARDNER[1]

Many of us have read or heard the statement made that before the modern screw cutting tools were invented screw threads were made by winding wire around the rod on which the thread was to be cut as a guide for the thread cutting tool. However, very few have actually seen this method used.

The following describes the manner in which a country jeweler used this scheme to do an otherwise impossible job. There was brought to him for repairs a clock of foreign make in which a screw conspicuously visible through the glass sides of the case was seen to be broken. It was about the size of our No. 6 gage, and was 5/8 inch long, having a head which was of fillister shape with a rounded top. The thread was cut to within 1/8 inch of the head and was found to be a metric thread for which the jeweler had no die. He first turned a head from round steel, slotted it with a hacksaw, and then blued it to the proper shade to match the similar screw heads. The head was then chucked in the lathe and a hole drilled in the under side of the head about one-half the diameter of the screw shank, after which this hole was slightly countersunk. A piece of round stock was then put into the lathe and an inch at one end reduced to the diameter of the shank. Just to the left of the shoulder thus formed a small hole was drilled through the rod. The ends of two pieces of brass wire, the diameter of which equaled one-half the lead of the screw, were then passed through this hole and secured by a tapering pin. The two wires were then wound in a close spiral about the rod, the end of one fastened by a clamp and the other removed. The remaining wire was then soldered to the rod in several places. This was then placed in the lathe and a double-pointed thread tool employed to cut the threads, the wire serving as a guide for the thread tool. The shank was then cut to the proper length, and a portion at the upper end was turned down to fit the hole drilled in the screw head. The head was then dipped first into water and then into powdered boric acid to prevent discoloration in the final operation. The head and the shank were then joined by hard solder.

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TUBE FORMING DIES

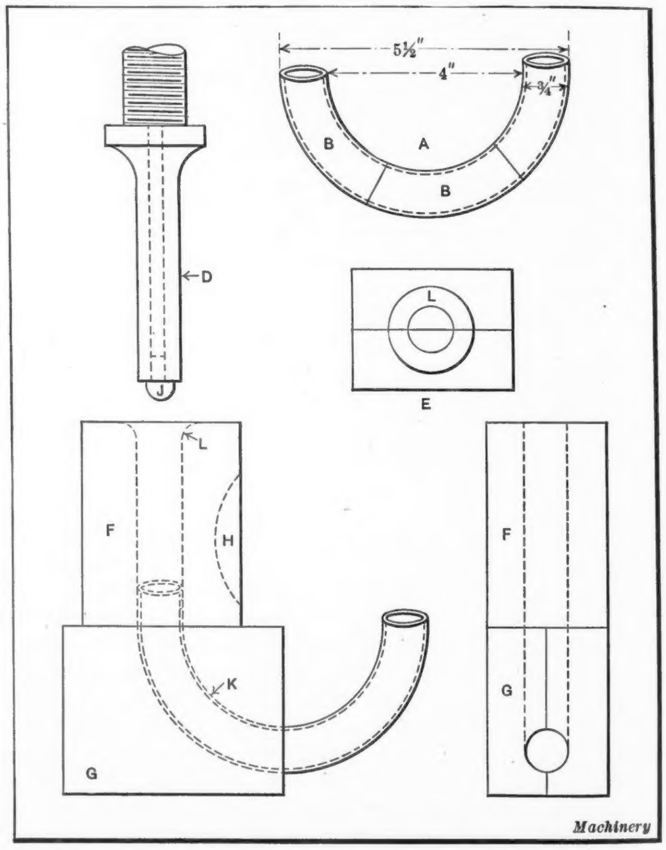
BY G. R. SMITH[1]

While the field of press tools and forming operations is very extensive, hardly any formation being considered strictly impossible, very little is heard or written of the so-called "squirt" dies. These, perhaps, are a little out of the ordinary run of press tools, but they render possible economical tube-forming operations. The dies described have been successfully used in the filling of a large government contract, which could be profitably filled only by reducing the work to a one-operation job.

The piece shown at *A* in the accompanying illustration is made in several different sizes from both cold-rolled steel and soft brass. The inside diameter of the finished piece is 4 inches and the outside diameter about 5 1/2 inches; 3/4-inch tubing with walls 0.030, 0.045, and 0.0625 inch thick is used. The tube is cut into pieces 6 1/2 inches long, which is a trifle more than is really required, so that some stock is trimmed off with a saw.

Construction of Punch and Dies

The punch *D* is made of tool steel and has a pilot *J* that may be easily removed in case of breakage or wear. As the



Tube Forming Die and Piece to be formed

punch descends, this pilot enters the bore of the tube, shifting it to a central position, where the forming takes place. As it is the bottom of the punch that really does the work, this part is subject to considerable wear and requires grinding occasionally. The punch should be about 0.008 to 0.010 inch smaller in diameter than the bore of the die so as to reduce the friction, or roughing of the die, from the action of the punch. Both the punch and the bore in the die must be kept perfectly smooth and highly polished. Great care must be taken in setting up these tools to have the punch enter the die just as far as possible, so that it will push the work to the lowest possible point; but it must not enter the curved part of the die or even touch the sides of this part, as this will roughen the bore and cause considerable trouble.

The die proper is made of four tool-steel sections, which are held together by dowel-pins and fillister-head machine

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screws; it is sunk in the standard die-bolster the necessary amount. At *E* is shown the two top sections *F* of the die and the method used in building; these sections are fastened to the bottom die-blocks *G* by dowel-pins and machine screws. Blocks *F* should be long enough to contain nearly three-fourths of the length of the tube when it is placed in position for forming, thus reducing the tendency for the piece to buckle when the forming takes place. It is not necessary for the bore in these blocks to be as highly polished as in the bottom blocks, for their chief function is to start the piece in its forming. A good-sized radius *L* is ground at the top of these blocks around the opening of the bore. This allows the easy insertion of the piece by the operator, and also allows the piece to shift slightly, as required, when carried to position by the pilot of the punch. If the radius around this opening is too small or if there is no radius at all, trouble will at once be experienced by the metal shearing off the sides of the tube as well as by the buckling of the piece when the punch starts to descend.

The two bottom blocks *G* do the forming, and therefore must be very accurate. Their joint is at right angles to that of the top blocks and they must fit together closely. No cracks whatever can exist along the turn of the bore *K* where the blocks come together, as they will form scratches on the sides of the piece; besides, they will collect small bits of the metal which, in time, will force the blocks still further apart and cause no end of trouble. These blocks are hardened and highly polished and are held together by dowel-pins and machine screws or they can be shrunk in a solid die-block. The bore *K* may be smoothed and polished by drawing strips of emery cloth through it, or it may be lapped out with round pieces of felt that fit the bore closely and are coated with flour of emery and oil. Great care must be taken when polishing the die to see that not the slightest bit of emery is left. It is a good plan to wash dies that have been stoned or polished in a can of gasoline before they are used.

Short sections, as shown at *B*, may also be made by this method as well as sections greater than a half circle. Nearly a complete circle may be formed by grinding away a portion of the top sections *F*, as shown at *H*. By this method several sizes are now being made in both brass and steel.

Lubricant Used

For brass, pure lard oil is used as a lubricant; while for steel tubing, the most successful lubricant is an emulsion of lard oil and precipitated chalk. This is cheap, easy to make, and easy to remove from the work if required. It is mixed to about the consistency of thick paint and works much better if left to stand over night, so as to jelly. In fact, the older it gets, if kept clean, the better it becomes. It is, perhaps, the most successful lubricant for steel drawing and forming used. In all drawing work where lard oil or other lubricant has not been satisfactory this emulsion will be found to work admirably. In most cases of drawing work, where the tools are correct and in good shape, if the oils and lubricants fail it is because they are too light; that is, they have not enough body to protect the piece being worked. Where rubbing and scratching takes place in heavy steel drawing and forming, the lubricant must be heavy enough to form a slight film between the die and the work. In the case shown, the piece must undergo both a drawing and an upsetting action of the metal at the same time and at the same point that it is forced around the radius or turn of the bore in the bottom die-blocks; a lubricant of the requisite properties, as well as a perfectly smooth bore and correctly built dies, are therefore necessary. With these conditions existing the working of these dies is very successful.

Operation of Press

The machine used on this work is a Bliss No. 1½ toggle-action drawing press, the center plunger only being used. The stroke is slower and more uniform than in the single-action presses and thus gives the best results for this work. This press has an 8½-inch stroke. If the work is to be done on a press having a stroke less than the length of the tube before it is formed, the die may be built on a sliding base so that it may be swung out from under the punch in order that the piece may be put into position to be formed.

As the punch pushes the work only half way through the lower die, another straight tube must be placed in the top die to act as a punch and push out the first piece when it is formed; there is always one piece left in the die. As can be seen, there is very little work for each punch to do, as the piece already in the die is formed and only requires to be pushed out. If short sections of the circle, as shown at *B*, are to be made, they may be used as slugs between two longer pieces; in this way several sizes may be formed at the same time.

* * *

TECHNICAL SOCIETIES IN THE WORKSHOP

BY MARK MEREDITH[1]

While there is no reason to believe that the practice was at all general, it is known that before the war several big engineering firms and railway companies had encouraged the establishment by their employes of societies which met periodically to hear lectures or conduct discussions on technical subjects. The scheme is one that may be developed in the near future. It is important that the interest of the workmen in their work should be encouraged and maintained. The manager of a munitions factory found that the men and women engaged in fuse making regarded the high standard of workmanship required as unnecessarily exacting. They were engaged on different operations, and each group had no idea of the relationship of the parts it was making with the parts made by other groups. The manager instituted a course of lectures in which the whole fuse was described, the coordination of its parts was explained, and the reasons why high accuracy was essential were discussed. The result was marked. Each group understood how its work dovetailed in with that of another group. A real spirit of cooperation was aroused, and not only did the output of the factory increase, but it was soon obvious that the workers were taking a keen interest in their occupation.

A practice that has proved so useful for one purpose may prove equally useful for others, and among the new schemes of instructing workmen we shall, without doubt, see the development of technical societies in the shops. An institution of this kind has been established by Allen West & Co., of Brighton, England. It was recognized that it would be useful to impart to the employes a knowledge of machine characteristics, instruction being obtained by one or two outside or commercial engineers. Again, the draftsmen have little chance of enlarging their engineering perspective, and in these days of specializing, their field tends to become very narrow. In order to insure the rapid diffusion of information regarding new developments, a certain company established a society a few months ago which meets once every two weeks. At the earlier meetings the company's own products were discussed, but subsequently outside engineers were invited to describe other apparatus. Then lectures on the work for which the company's products were employed were given, and while membership is at present limited to the staff, guests have been invited, and the average attendance has risen to about one hundred. The directors have presented the society with a lantern apparatus and contributed to the expense of starting a library. This is an excellent beginning, and it is not only educational work of a valuable kind, but the existence of a society of this kind cannot fail to encourage the spirit of cooperation, which is an invaluable asset in every business.

* * *

Recently, 105,000 pounds of steel forgings were made in one day by a crew of twelve men operating a 1000-ton hydraulic press at the Essington plant of the Westinghouse Electric & Mfg. Co.

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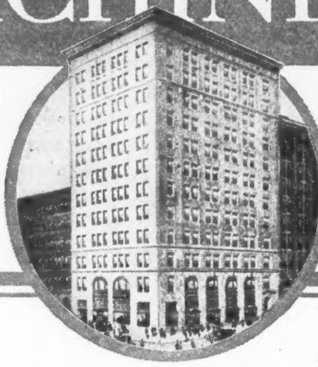


CONVERTING FACTORIES TO WAR WORK

One of the most remarkable transformations that have ever taken place in America is the conversion, now quietly going on, of industries that have been classified as non-essential to the conduct of the war to the production of war materials. As an example, may be mentioned the case of a shop making gas ranges. The Resources and Conversion Section of the War Industries Board requested from the engineering subcommittee in the New York district a report as to whether this factory was suitable for conversion into one making a certain type of shell. Members of the committee visited the factory and after making a thorough survey of its facilities and labor supply, of the qualifications of the executives, and of other conditions of importance in this connection, found that, while making so entirely different a product for peace purposes, it could be converted, by the investment of about $60,000, into a shop capable of producing more than $1,000,000 worth of war materials a year. The committee's report recommended, of course, that the War Department take advantage of the excellent facilities already existing in this plant for the manufacture of war materials, rather than undertake to build a new factory for this work.

In the same way hundreds of factories all over the country, engaged in work that is not essential to the conduct of the war, have been or shortly will be converted into producers of war materials. Their organizations will be kept together, their capital will not lie idle or become wasted, and their facilities will be used to the fullest extent for the particular kind of war work for which they are best fitted. This is constructive work of the greatest value at this time and will prove one of the most important steps toward conserving our industries for the work to be done after the war.

* * *

SCRAP IRON WANTED

As the largest proportion of the war materials required by the Government is represented by products of iron and steel, such as rifles, machine guns, cannon, shells, torpedoes, tanks, engines, ships, and motor trucks, the national iron and steel supply is one of the determining factors of the effectiveness of our Army and Navy. Manufacturers all over the country are therefore being requested to sell all the scrap iron and steel available in their various plants, so that this may be remanufactured into iron and steel for war requirements. It has been suggested that the slogan "Sell Your Scrap" should be nationally adopted in war time, when the shortage of all raw materials is acute. From the steel producers' point of view, the turning back of all scrap materials into productive channels is a matter that ranks in importance with the selling of Liberty Bonds and Thrift Stamps, because if the steel makers are provided with plenty of scrap materials they, in turn, will be able to increase the supply of iron and steel for government work. It is certain that if the entire country were awakened to the importance of the need of scrap, manufacturers of iron and steel would be greatly helped. The dealers in scrap can be depended upon to see that the steel mills get all that is collected; but the dealers do not produce the scrap. That is found in manufacturing establishments, and every pound of it should be collected and sold at the present time.

* * *

STANDARDIZATION OF GEARING

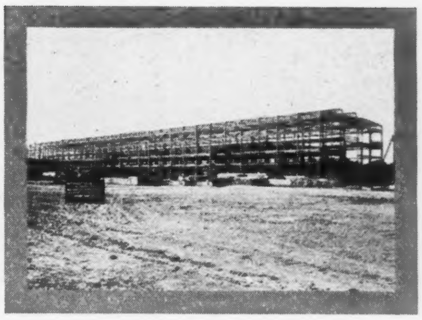
The American Gear Manufacturers' Association has entered upon a constructive work of value not only to the members of the association, but to the mechanical industries at large. The association, although but two years old, has attacked a problem which has baffled engineering societies for years—the standardization of gearing. As every man engaged in the mechanical industries knows, gearing has been standardized only to a limited degree, and there have always been a great many special conditions that have been met by special designs. It has been difficult to obtain concerted action toward uniform design and standardized methods.

There is no doubt, however, that much greater uniformity and standardization in gearing practice is possible, and the American Gear Manufacturers' Association, including as it does all the leading gear manufacturers of the country and counting among its members some of the foremost gearing experts, is well fitted to accomplish this. Judging by the results already obtained, the association bids fair to achieve a large measure of success and to perform a constructive service of great value.

* * *

VIGILANT MANAGEMENT COUNTS

The shortage of labor has forced many manufacturers to increase their production without proportionately increasing the number of operatives employed. A few years ago many manufacturers believed that they had reached the highest degree of efficiency in production; but the war, which has upset so many other accepted beliefs, caused an entire revision of the theories of efficiency. One plant, where formerly a thousand operatives were employed, is now maintaining its previous output with a force of seven hundred. Another plant has increased its output 50 per cent without increasing its working force, and a third plant has doubled its output without increasing its manufacturing facilities, by slightly increasing its force. These are only a few examples of what is being accomplished by vigilant management all over the country. The executive ability of manufacturers is being tested as never before. Men do not generally work any harder now than they formerly did; but in the past, minor details that are now given very careful attention often took care of themselves, and many little leaks that seemed individually unimportant resulted in a large aggregate loss of time and material. The increased output per operator is due to the elimination of waste time, and the saving in material through attention to details. Another and a larger increase in production would result if the workers, realizing that they are truly soldiers who are fighting for victory, would exert themselves to the utmost until the victory is won.

Efficiency in a Democracy

WAR-TIME conditions impose great handicaps upon the management of manufacturing plants, but those who are closely in touch with industrial conditions throughout this country cannot help being deeply impressed by the indomitable spirit and resourcefulness shown by American executives responsible for production. It is surprising and gratifying to note how effectively they have coordinated their efforts with those of the Government, enlisting the entire resources of the country in the military establishment. The ability and resourcefulness shown are striking examples of *democratic* efficiency.

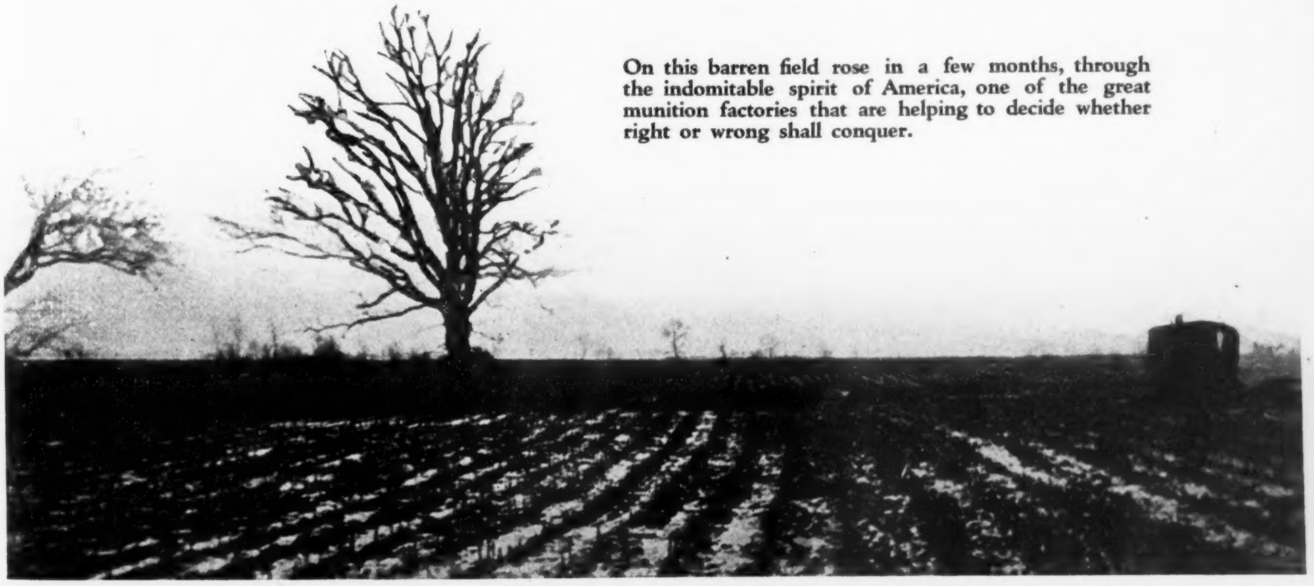
Everyone familiar with war-time industrial conditions knows of the scarcity of materials used in factory construction, of machine tools and other equipment, and of labor. Notwithstanding these handicaps, a firm formerly engaged in manufacturing an entirely different product, accepted a government contract for building 1000 naval gun mounts. All this concern had to start with was a staff of experienced mechanical engineers. The problem presented what would ordinarily appear to be insurmountable difficulties, but eight months after signing the contract this resourceful company had not only erected and completely equipped a factory and put together an efficient working organization, but was actually delivering gun mounts to the Government! The skill with which preparations were made is demonstrated by the fact that they were all accepted by the naval inspectors.

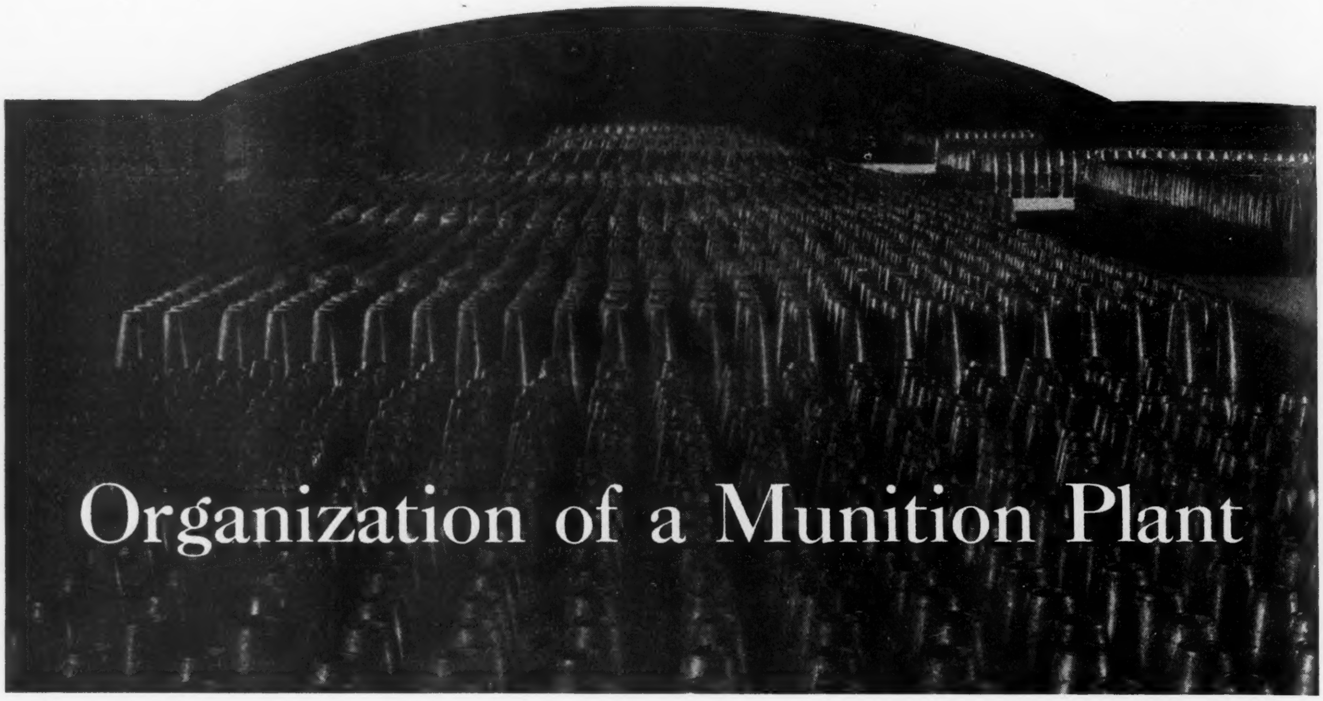
Another striking example of American initiative in handling government war work is the following: An especially dense grade of steel is required to make the rollers and raceways for roller bearings. One plant making bearings of this type for use in army motor trucks found itself unable to purchase the necessary quantity of raw material. If the management of this concern had been disposed to follow the line of least resistance, they would have presented their case to the proper authorities in Washington together with a request for priority privileges in buying steel. This would have solved their particular problem, but it would only have meant taking steel from other plants where it was equally necessary. A survey of the industrial conditions revealed the fact that great quantities of steel chips could be purchased from munition plants, and so four six-ton Héroult electric steel refining furnaces and the necessary auxiliary equipment were installed at the roller bearing plant to provide for converting these chips into steel. Electric steel-making is known to be a complicated process, yet all of its intricacies have been successfully mastered by this firm, and it is now producing a hundred tons of seamless steel tubing and solid bars every day.

Early in October, our newspapers told of the destruction of one of the largest shell-loading plants in the country. The explosion occurred late on Friday night, and on Saturday morning the buildings which had housed this mammoth enterprise were in flames. But Saturday morning also witnessed the presence of engineers on the ground, actively engaged in planning for the work of reconstruction; and this work was started as soon as the ruins were cool enough to enable laborers to begin clearing away the debris. This is typical of how our engineers overcome all kinds of difficulties. It is this indomitable spirit and resourcefulness which will assure our armies of the supplies required to bring the war to a speedy and victorious conclusion.

The great claim for German autocracy was its efficiency. Here are a few of the innumerable examples of *democratic* efficiency, which for speed, originality, and results cannot be matched. Autocracy has been met in every field of human effort—scientific, industrial, and military—and in every one has been signally beaten.

On this barren field rose in a few months, through the indomitable spirit of America, one of the great munition factories that are helping to decide whether right or wrong shall conquer.





Organization of a Munition Plant

By GEORGE A. NEUBAUER[1] and ERIK OBERG[2]

System and Organization of the Buffalo Pitts Co., Buffalo, N. Y., engaged in the Making of 4.7-inch High-explosive Shells

WHILE a great deal has been published about the mechanical methods used in the manufacture of shells, comparatively little attention has been given to the organization and systems employed by shell making plants, and MACHINERY has therefore obtained, with the approval of the Ordnance Department and through the courtesy of F. G. Batchellor, general manager of the Buffalo Pitts Co., Buffalo, N. Y., the details relating to the organization of this company for the making of 4.7-inch high-explosive shells. As the organization and system of this company is remarkable for its simplicity and the absence of red tape, it is believed that an outline of the organization and system used may prove of considerable value to other manufacturers engaged in shell making, as well as to plants engaged in other lines of interchangeable manufacture. It is evident that the principles can be applied to any line of production where the amount of repetition work done makes it possible to use so simple a system.

The output of the Buffalo Pitts Co. of 4.7-inch shells is about 1200 per day, but with the present equipment it is expected to be able to increase this production to 1500 shells per day. This plant is only one of many making this size shell, the total daily output of all the plants being probably in the neighborhood of 30,000. The general organization of the shell plant of the Buffalo Pitts Co. is given in outline in Fig. 1. There are four definite departments, the heads of each being responsible to a general manager. These are the operating, inspection, routing, and engineering departments.

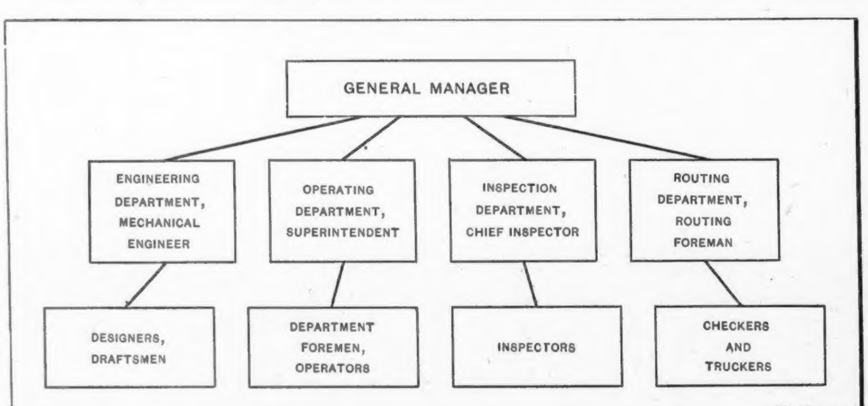


Fig. 1. Scheme of Organization of the Buffalo Pitts Shell Plant

[1]Mechanical Engineer, Buffalo Pitts Co., Buffalo, N. Y.
[2]Editor of MACHINERY.

Operating Department

The operating department is under the charge of a superintendent and his assistants, and is responsible for the machining operations, for making all tools and gages, for setting up and tooling the machines, for keeping the machines in good working order, and for the repairs of the machines. The tool-room is also organized under the operating department under the charge of the superintendent. Only the men actually engaged in the machining operations are under his control, and these are hired through the employment department.

Inspection Department

The inspection department is under the charge of a chief inspector and assistants, and is responsible for the quality of all work passing through the shop, the inspection after every machining operation, and the final inspection before the shells are passed to the government inspectors. The inspection department receives its gages from the operating department where these gages are made and checked. The inspection department also keeps all records required to show the number of shells passing through the shops at all times; all necessary tests are also made by this department, and in general, it is expected to take care that all shells are made exactly as required by the government specifications.

Routing Department

The routing department has charge of the movements of the shells through the plant. It is under the charge of a routing foreman who has control of the order in which the shells are machined. The work of this depart-

ment consists in taking care that the machines are supplied with shells and that shells are machined in the proper sequence. Responsibility for keeping the different heat numbers separate rests also with this department, and the man in charge is supposed to anticipate congestion or shortage at any machine or in any department, and to make the required provisions to prevent either congestion or shortage by arranging with the operating department to reduce or accelerate the output in any one department as required. Hence, the work of the routing department is highly important, as upon it depends largely the continuous flow of the work from department to department through the plant.

Engineering Department

The engineering department is under the charge of the mechanical engineer. This department may be called upon by any of the other departments—the operating department, the inspection department, or the routing department—for new designs of equipment, gages, or other devices. While the gages are made in the tool-room, they are designed by the engineering department, which furnishes either original designs or makes designs in accordance with specifications furnished by the Government.

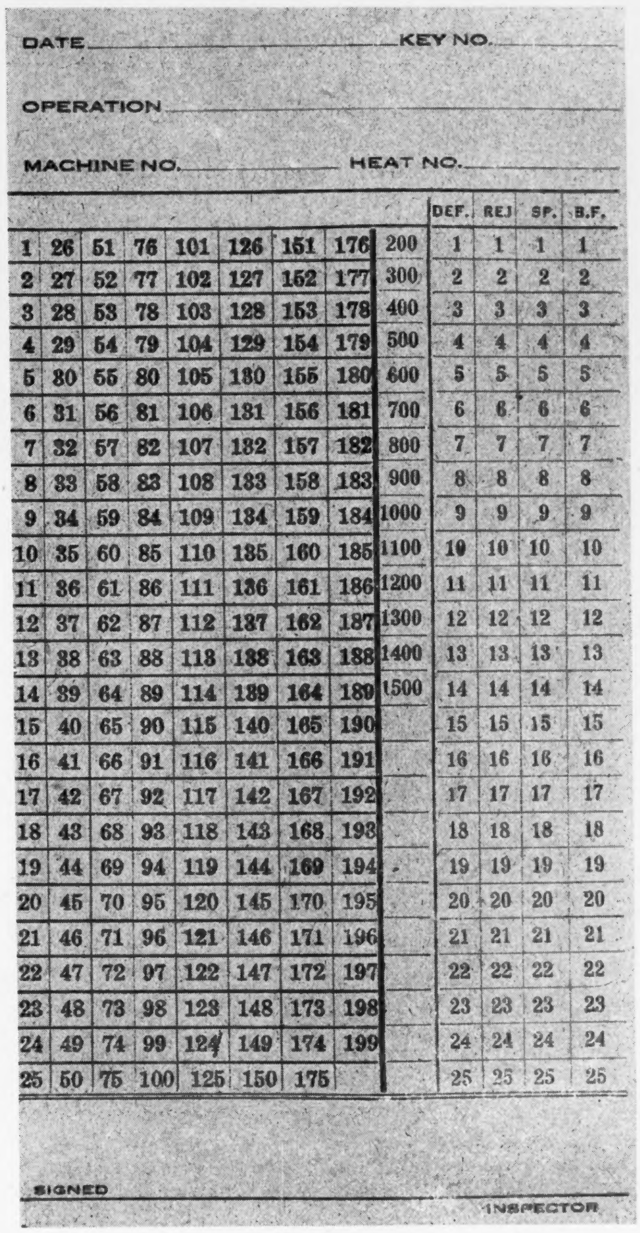
Each of the heads of these departments is responsible only to the general manager. An employment bureau takes care of the hiring of men for all departments, but after being hired, the men in each department are under the direct authority of the head of that department.

System of Passing Work Through Shop

The forgings for the shells are received from outside forging concerns. When arriving at the plant, the numbers received are tallied from the shipper's statement by one of the Buffalo Pitts Co.'s inspectors and one government inspector. A big blackboard is provided on which the date, the car number, the number of forgings, and the heat number of the forgings are marked. The forgings belong to the Government, and after the records written down on the blackboard have been checked back against the bill of lading, the latter goes to the government inspector. Should there be any shortage in the forgings received, this shortage is reported by the Government to the forging plant. The record on the blackboard is kept permanently and is never erased. The shells are passed through the shop by heat numbers, all shells of the same heat number being kept together; this is necessary in order that the proper heat-treatment may be given to each lot, and also so that any defects may be properly referred back to a certain heat. These heat numbers are stamped on the forgings and are restamped during the machining operations whenever they are removed by such operations, so that they are continually on the shells until they pass out of the plant finished. As mentioned, the inspection department has charge of all the records relating to the shells while passing through the plant.

As the forgings are received, the different heats are piled separately in the yards, and the chief inspector is provided with a diagram showing exactly where the different heats are stored. He then orders the routing department to bring the shell forgings into the shop in accordance with two considerations, the first of which is the order in which it is best to run the shells through the plant according to the carbon and manganese content. This makes it possible to so select them that if shells of two heats should pass through the shop at once, they will be of a quality, as far as chemical analysis is concerned, that will make it possible to give them the same heat-treatment. The second consideration in selecting the shells that are to be passed into the shops is the arrangement of the available heats in the yard. Of course, if one heat should be so piled behind other heats that it is difficult to reach and handle, no attempt would be made to pass it through the shop until the other heats had been passed through and the obstructions thereby removed.

During a month about twenty heats are generally passed through the shop, and every department is provided at the beginning of the month, with a list of twenty heats, giving the order in which they will pass through the shop. The routing department brings them into the shop in the order given on this sheet and follows the shells through the shop, moving them by heats and keeping each heat together. The inspection department reports the number of shells of each heat that pass the inspectors after each operation, these reports giving the heat numbers as well as the number of shells. In this way a record is provided for the office showing how the work proceeds.


DATE ______ KEY NO. ______

OPERATION ______

MACHINE NO. ______ HEAT NO. ______

									DEF.	REJ	SP.	B.F.
1	26	51	76	101	126	151	176	200	1	1	1	1
2	27	52	77	102	127	152	177	300	2	2	2	2
3	28	53	78	103	128	153	178	400	3	3	3	3
4	29	54	79	104	129	154	179	500	4	4	4	4
5	30	55	80	105	130	155	180	600	5	5	5	5
6	31	56	81	106	131	156	181	700	6	6	6	6
7	32	57	82	107	132	157	182	800	7	7	7	7
8	33	58	83	108	133	158	183	900	8	8	8	8
9	34	59	84	109	134	159	184	1000	9	9	9	9
10	35	60	85	110	135	160	185	1100	10	10	10	10
11	36	61	86	111	136	161	186	1200	11	11	11	11
12	37	62	87	112	137	162	187	1300	12	12	12	12
13	38	63	88	113	138	163	188	1400	13	13	13	13
14	39	64	89	114	139	164	189	1500	14	14	14	14
15	40	65	90	115	140	165	190		15	15	15	15
16	41	66	91	116	141	166	191		16	16	16	16
17	42	67	92	117	142	167	192		17	17	17	17
18	43	68	93	118	143	168	193		18	18	18	18
19	44	69	94	119	144	169	194		19	19	19	19
20	45	70	95	120	145	170	195		20	20	20	20
21	46	71	96	121	146	171	196		21	21	21	21
22	47	72	97	122	147	172	197		22	22	22	22
23	48	73	98	123	148	173	198		23	23	23	23
24	49	74	99	124	149	174	199		24	24	24	24
25	50	75	100	125	150	175			25	25	25	25

SIGNED ______ INSPECTOR

Fig. 2. Inspectors' Tally Sheet

Inspectors' Tally Sheet

Fig. 2 shows the tally sheet used by the inspectors for keeping a complete record of the production in the plant. Assume, for example, that there are five machines employed on a certain operation, each machine having one operator. The inspector places five of the tally sheets shown in Fig. 2 in front of him on the table. Each morning he fills in the date in the space provided, the key number (which simply means the number of the operator), the name of the operation, the number of the machine, and the heat number. As each operator completes an operation, before the shell is passed to the inspector he marks the shell with the machine number, this mark being made with a steel stamp. Hence, the inspector, as he picks up each shell for inspection and tallying, knows which operator has performed the work. If the shells pass inspection, the inspector tallies the numbers in the columns to the left on the sheet by drawing one line diagonally across the numbers. When 199 shells have been passed, the next shell will be

tallied by drawing a line across the figure 200 in the ninth column, and the tally is continued by drawing a line diagonally in the opposite direction through the figures 1, 2, 3, etc., in the first columns. In this way this simple tally sheet can be used, by drawing lines in different directions and by other tally marks, until at least 1000 shells are tallied in this way. Of course, very few operations would make it possible for the operator to complete so many shells in a day. In most cases, less than 200 shells would constitute a day's work, and only the first eight columns would be required for tallying.

To the right on the tally slip are provided four columns headed respectively, "Def.," "Rej.," "Sp.," "B.F." These abbreviations stand for defective, rejected, spoiled, and bad forging, respectively. When the shells do not pass inspection, one of these columns will be tallied according to conditions.

A *defective shell* is one that is found defective by the inspector due to an error in a previous operation or a fault produced within the shop itself. As all work is paid for on a piece-work basis, the man performing the operation at the time the defect is detected, is paid for defective shells, as he is not responsible for the defect.

A *rejected shell* is one that is improperly machined and which can be corrected by a special operation. A special department is maintained for fixing up or correcting rejected shells. The operator is not paid for rejected shells, as he is responsible for the rejection, but is fined a nominal sum because the shell requires special machining thereafter to correct the defect.

A *spoiled shell* is one which is in such a condition that it cannot be repaired, but must be scrapped outright. The operator is not paid for spoiled work, but is fined a sum larger than that for a rejected shell.

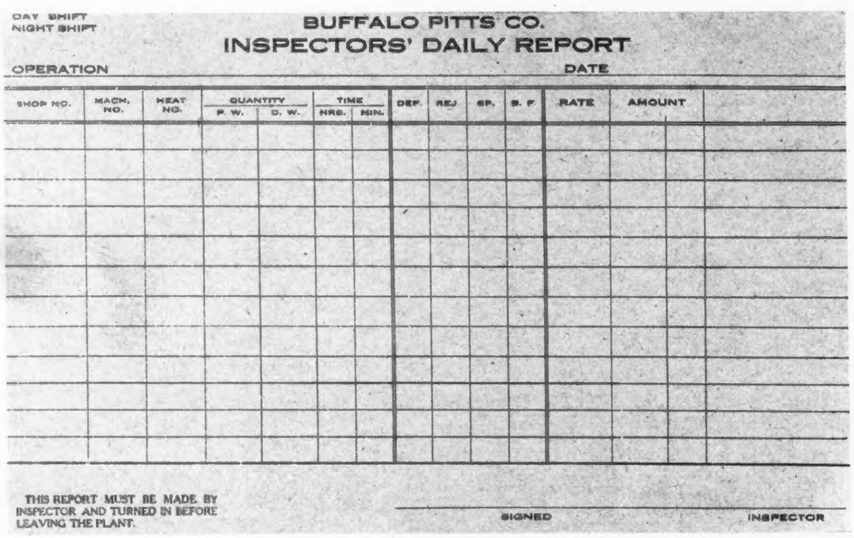


Fig. 3. Inspectors' Daily Report

A *bad forging* is a shell which at any operation shows a forging flaw, seam, or crack, which is apparently due to a defect in the forging. The number of bad forgings is reported to the Government, as the forgings have been ordered by and are the property of the Government.

Each tally sheet is provided with a duplicate beneath it, printed in the same way as the top sheet, and a carbon paper is placed between the two so that any mark that is made on the top sheet will be duplicated on the carbon copy. This copy is given to the operator. The tally sheet serves, therefore, both as a record from which the accounting department determines the pay-roll, and as a receipt to the operator for his day's work. Should he find that the count by the inspector is wrong, he reports this the next morning and an adjustment can be made immediately, while the matter is fresh in everybody's mind. The highest number tallied on the tally sheet is punched with the inspector's punch, so that there is no chance for alterations or erasures after the inspector has signed the tally sheet and punched the highest number.

Inspectors' Daily Report

At the end of each day the inspector prepares a report, as shown in Fig. 3. This report covers all the machines and operators that come under the supervision of each inspector. This report states the operation performed and gives the date. The column headed "Shop No." corresponds to the "Key No." on the tally sheet, Fig. 2, and is the operator's identification number. Then follow records of the machine number, the heat number, and the quantity of shells produced by piece-work (P. W.) and day work (D. W.). While the operators work on piece-work under normal conditions, they may be transferred to a day work rate in case of the breakdown of a machine, or if, for some other cause, the operator is interrupted on his piece-work. Every operator has a time rate as well as a piece rate, so that any emergency of this kind will be taken care of. Sometimes the operator may be employed correcting shells found defective in inspection, and in that case he will be working on his day work rate for the time required for this work. This card also gives a complete record of defective, rejected, spoiled, and bad forging shells as per the inspectors' tally sheets. The columns headed "Rate" and "Amount" are filled in by the accounting department in preparing the pay-roll. As noted on the report, it must be made by the inspector daily, and turned in to the accounting department before he leaves the plant. The tally sheets shown in Fig. 2 are kept by the inspection department.

Daily Production Report

From the inspectors' daily reports from the various departments in the shop, the daily production report shown in Fig. 4 is made out. This report gives complete details as to the total number of good shells that have passed inspection from every machine in the shop, and also records the defective, rejected, spoiled, and bad forging shells. Copies of this report go daily to the general manager, the government inspector, the engineering department, the superintendent, and the accounting department, and to any other department head who needs to have a complete record of the work of the shop. It will be seen that this report gives the executive heads of the plant an opportunity to see at a glance if anything goes wrong with the production at any particular operation, or at any particular machine, and an opportunity is offered to investigate the difficulty immediately and remedy the trouble. The daily production reports are made out on white paper for the day shift and on yellow paper for the night shift so as to make it easy to distinguish between the two. The report shown in Fig. 4 is for a night shift, and hence records are missing for a number of operations like painting, marking, shipment, etc., which are performed only by the day force, it being possible for the day force to perform these operations for both shifts during the course of the day.

Passing the Completed Shells to the Government

After the company has made its last inspection of the shells, they are passed to the government inspection room in lots of approximately 250 at a time. A tally is kept outside of the government inspection room on which the number of shells passing into the inspection room is marked. The Government also keeps a similar tally inside the inspection room, and these two are compared each night to determine that no mistakes have been made. If the government inspectors reject a shell, a tag is put on the shell and the shell is put on a truck in the government inspection room. The number of shells thus returned is marked on the tally

F 181-1000-7-18

BUFFALO PITTS COMPANY

SHELL DEPARTMENT

DAILY PRODUCTION REPORT

NIGHT SHIFT
~~DAY SHIFT~~

DATE ________

OPER. NO.	MACH. NO.	OPERATION	TOTAL GOOD	BAD DEF.	BAD REJ.	BAD SP.	BAD B. F.
1		Receiving and Tallying					
2	2A	Rough Face Inside	577				
	2B	" " "					
	2C	" " "					
	2D	" " "					
3X	3XA	Cut Off Open End					
	3XB	" " " "					
3Y	3YA	Centering Base End					
3Z	3ZA	Cutting Off Base					
	3ZB	" " "					
3	3A	Cut Off Both Ends and Center	96				
	3B	" " " " " "	128				
	3C	" " " " " "	65				
	3D	" " " " " "	105				
	3E	" " " " " "	89				
	3F	" " " " " "	78				
4	4A	Rough Turning Outside					
	4B	" " "	26				
	4C	" " "					
	4D	" " "	156				
	4E	" " "					
	4F	" " "	105				
	4G	" " "	131				
	4H	" " "					
	4I	" " "	168				
5	5A	Rough Bore Inside	140				
	5B	" " "	138				
	5C	" " "	138				
	5D	" " "	134				
	5E	" " "					
	5F	" " "					
	5G	" " "					
6	6A	Finish Bore Inside	67				
	6B	" " "					
	6C	" " "	80				
	6D	" " "	38				
	6E	" " "					
	6F	" " "	17				
	6G	" " "	47				
	6H	" " "	17				
	6I	" " "	65				
	6J	" " "	34				
7	7A	Reface Base	355				
	7B	" "	277				
8	8A	Recenter	860				
	8B	"					
9	9A	Nosing	474				
10	10A	Hardening Furnace					
	10B	" "	430				
11	11A	Annealing	260				
	11B	"	266				
12	12A	Bore Fuse Hole	65				
	12B	" " "	60				
	12C	" " "	66				
	12D	" " "	105				
	12E	" " "	84				
	12F	" " "	82				

OPER. NO.	MACH. NO.	OPERATION	TOTAL GOOD	BAD DEF.	BAD REJ.	BAD SP.	BAD B. F.
13	13A	First Wash	560				
14	14A	Sand Blast	560				
	14B	" "					
	14C	" "					
15	15A	Re-Turn	145				
	15B	"	130				
	15C	"	81				
	15D	"	91		1	2	
X16	X16A	Thread Recess	731				
16	16A	Finish Turn and Profile					
	16B	" " " "	162	12	1		
	16C	" " " "					
	16D	" " " "	170	14			
	16E	" " " "					
	16F	" " " "					
	16G	" " " "	80	7			
17	17A	Grind Bourrelet	452				
	17B	" "					
	17C	" "					
18	18A	Cut Off Base Projection	450				
	18B	" " " "	300				
19	19A	Weigh and Mark	355				
X19	X19A	Swipe Inside	460				
	X19B	" "					
20	20A	Face Base	93				
	20B	" "	260				
	20C	" "					
21	21A	Band and Crimping Groove	414		28		
	21B	" " " "					
	21C	" " " "					
22	22A	Base Cover Groove					
	22B	" " "					
	22C	" " "	568				
23	23A	Knurl	567				
24	24A	Mill Stabbing Groove	770				
25	25A	Ream Fuse Hole	529		2		
26	26A	Milling thread					
	26B	" "	861		12		
	26C	" "					
	26D	" "					
	26E	" "					
27	27A	Clean Band Groove					
28	28A	Press Copper Band	450				
	28B	" " "					
29	29A	Turn Copper Band					
	29B	" " "					
30	30A	Rivet Base Plate					
31	31A	Second Wash Shells	508				
32	32A	Varnish Inside					
33		Mark Shells					
34		Varnish Outside of Shells					
35		Shipment					

Fig. 4. Daily Production Report made out from the Inspectors' Daily Report received from the Various Departments

card, both in the government inspection room and in the shop inspection department. The shells are returned to the shop inspection department, and the chief inspector goes over these rejected shells personally. If he does not agree with the opinion of the government inspectors, he confers with the chief government inspector, and a few more shells are usually accepted as a result of this conference. Those that are finally rejected go to a special department where the errors are corrected and any defects made good. The government inspector then stamps the government's inspection stamps on all good shells, and from that time on the shells are government property. After stamping, the shells pass into the paint shop and shipping room, and are shipped from there according to heat numbers.

The company must account for all forgings received. The total of the shipped shells, the spoiled shells, and those used for test purposes must equal the total number of forgings in the heat that have been received. Spoiled or bad forgings are stored away, and adjustment is made with the Government at intervals. The actual report of the shipments made is kept by the Government and is used in determining the payments to be made to the company. The company's record is kept directly on the daily production report, Fig. 4, under the heading, "Painting Outside of Shells" which shows the number of shells that have actually been accepted by the Government during the day for which the report is made.

Methods for Encouraging Increased Production

The work at the Buffalo Pitts Co. is done almost entirely upon the piece-work basis, so that every operator is paid in proportion to the work he performs, and thus increased efforts are given a proportionate reward. In addition, however, it has been deemed advisable to give some kind of public recognition of the best performance in the shop. A large blackboard is therefore provided on which is listed the highest record for any particular operation that has been obtained at any time by an operator in the shop, and in addition, the highest record for the two previous days. Furthermore, a board is hung over the machine operated by the man who has obtained the highest record for any one operation, this board containing the man's name and the record expressed in the number of shells produced in one day. One board, of course, is provided for each set of machines performing the same operation, so that within each group the operator with the highest record is given a recognition of his performance. By means similar to this, it is possible to encourage the men to put forth their best efforts, as this recognition of their work stimulates them and gives them an incentive in addition to that of earning more money by producing more work.

* * *

AIRPLANE MOTIVE POWER IMPROVEMENT

At present, the Government is concentrating all its energies on the quick production of the best design of airplane motor, and for manufacturing reasons it has been necessary to standardize this design. However, there is still room for improvement. In the average airplane motor only about 25 per cent of the energy of the fuel is delivered by the engine shaft to the propeller; about 5 per cent of the energy is consumed by engine friction, 30 per cent is lost by cooling, and 40 per cent escapes in the exhaust. As the mechanical efficiency of the propeller is 75 per cent, only about 19 per cent of the energy of the fuel is available for flight. Just now, the important object is to secure more work per pound of fuel carried, to secure steady, reliable operation, and to obtain lighter weights than 2 to 2½ pounds per horsepower.

* * *

A British patent has been granted on a method of preventing the shrinkage of castings by electricity. Electrodes are so placed that a current may be passed through the thinner and less dense parts of the casting to prevent their cooling more rapidly than the thicker parts. The amount of current required is not very large, as the heat need be applied only when the casting is in the critical temperature periods.

COMPENSATION FOR ACCIDENTS CAUSED BY PNEUMATIC TOOLS

BY CHESLA C. SHERLOCK[1]

The introduction of highly specialized machinery into modern industry has served to cheapen the manufactured product and has greatly increased production. However, it has also greatly increased the hazards of work. It might reasonably be said that the greater the number of machines installed in a shop or factory, the greater is the hazard of work. All are familiar with the time-honored injunction of the common law to employers: "It is the duty of the employer to furnish a reasonably safe place in which to work." The invention and use of machinery in industrial life, especially now, when there is a machine for almost every conceivable task, has doubled and trebled the ordinary hazards that confronted the craftsmen of earlier days. The hazards of work in those days, compared with the hazards of today, seem trivial indeed. This increased hazard of work has not had to fit into an ancient and outworn theory of law by any means. The workmen's compensation acts, in some of the states, the safety appliance acts, and the employer's liability acts seek to protect the workman. But however much the common law has been changed by these acts and others, its spirit still exists; namely, the workman must be given a safe place in which to work.

Many employers think that so long as they comply with the terms and conditions of the workmen's compensation acts they have discharged their full duty to the state and to the workman. They feel that their compensation insurance policy is ample evidence of their disposition to obey the law. But the employer's duty does not end here. It is one thing to say that an employer shall do thus and so to keep his workmen from being injured and another thing to say what he shall do after they have been injured. Besides, the compensation acts are not, as yet, effective in every jurisdiction in this country. Employers doing business in several states have no way of knowing what their full liability in the case of the hazards of work is unless they are acquainted with the common law, the statutes, and the interpretations placed upon them by the several courts.

Accidents Caused by Faulty Pneumatic Hammers

Of all the classes of machines in use at the present time, possibly none are more generally used and as well known as pneumatic tools. They are a fruitful source of injury, as has been shown by the cases that have been brought to the attention of the courts. In a Nebraska case, the plaintiff, who was employed in a railway repair shop, while repairing a boiler lost an eye from the effects of being struck in the eye by the plunger of a pneumatic hammer. There was considerable dispute as to the manner in which the injury was received. It was contended by the plaintiff that he was using the pneumatic hammer on the boiler when the plunger flew off the hammer and struck him in the eye. The defendant company contended that the plunger flew off the hammer while the latter was lying on the floor where it had been left by other workmen, who had not turned off the air current. The court held that it made no difference and that the plaintiff's verdict should be affirmed.

In a Massachusetts case, it was the duty of the plaintiff, while aiding in the construction of a bridge, to help operate a pneumatic hammer used in riveting beams and other parts together. The evidence showed that the air was turned off by means of a trigger, and that if the hammer was in a proper state of repair, the piston would stop, but that if the trigger was handled so as to admit air, the piston would fly out unless held against something. The injury complained of was caused by the sudden starting of the hammer, the piston flying out and destroying the plaintiff's eye. During the trial it was shown that a pneumatic hammer needs frequent cleaning and inspection. If dirt gets under the valve that shuts off the air current, it will cause the hammer

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to move and revolve; or if the spring operating the valve becomes inelastic through long usage and does not close the valve tightly, the result is the same. The evidence showed that this particular hammer had not been inspected or cleaned for a long period of time. On the first trial, the verdict had been for the employer, but the court set it aside and ordered a new trial, stating that the evidence was properly for the jury under the employer's common-law liability.

Accidents Caused by Foremen Handling Workmen's Tools

In a Washington case, the plaintiff was employed in the construction of a freight conveyor, but the pneumatic hammer was in the hands of the foreman at the time of the accident. It was shown that in some manner the hammer had been removed both from the rivet the foreman was driving and from the steel beam, and that it was pointed in the direction of the plaintiff, so that the rivet set was forced out and thrown with great force, striking the plaintiff in the face. It was also shown that it was customary in the use of pneumatic hammers to use a wire attachment as a safety device, but that such device had not been used in the present case. The court held that it was a case for the jury, under common-law liability, and affirmed a verdict in favor of the plaintiff.

In an Oregon case, the plaintiff had been using a pneumatic hammer, but had laid it down to go for a drink of water. While he was away, the foreman picked up the hammer and riveted a few bolts, but something caused the plunger and die to fall out; he then commenced to repair the hammer. When the plaintiff returned from getting his drink, he picked up the hammer. The foreman, in some manner, had pressed the trigger which admitted air from the valve, with the result that when the plaintiff started to use it the plunger was thrown with great force against his skull, thereby fracturing it. Judgment was for the plaintiff, the court holding that the foreman was, at the time of the accident, engaged in preparing for the plaintiff a suitable and proper tool for the service in which he was engaged, and "in the performance of this duty the master's representative so conducted himself and so manipulated the appliance that the injury resulted to the plaintiff."

Accidents Caused by Fellow Employes

In an Alabama case, a slightly different situation arose. The plaintiff was employed as a bucker, whose duty it is to hold a hammer or maul against the rivet while a man on the opposite side hammers it with an air hammer. The operator of the air hammer must govern his stroke so as to hit the rivet a very light stroke until the rivet is plugged in the hole, so that the bucker can hold it. In this case the riveter struck the rivet with the full force of his hammer, causing it to fly out of the hole and strike the plaintiff, which resulted in the injuries complained of.

In a Delaware case, the plaintiff was employed as a blacksmith's helper, and worked with a steam hammer that had a stroke of about three feet. The blows of the hammer were controlled by a "hammer man," who happened to be a boy. The plaintiff was instructed to clean the scales from the form and had placed his hand under the hammer for this purpose, when the boy started the hammer, crushing the plaintiff's hand. The court instructed the jury that the hammer boy and the plaintiff were fellow-servants, and that the plaintiff could not recover damages from the employer unless the employer had been negligent in the selection of this hammer boy. The jury seemed to think that such was the case, as they returned a verdict for the plaintiff.

Defective Appliances

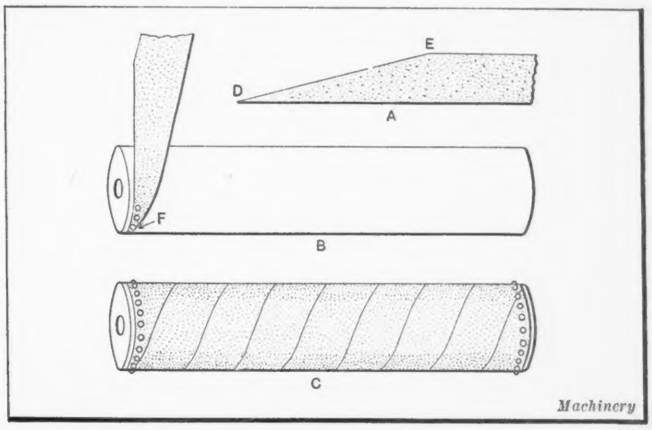
In an Iowa case, the plaintiff was engaged as a helper in a wheel factory and had to work with a trip or fall hammer. The evidence showed that this trip hammer was defective and would often deliver a second blow when only one was intended. It was necessary for the plaintiff to place his hands under the hammer in order to remove the hubs which were being straightened by it, but, being young and inexperienced, he did not know that it was in a defective condition. It was customary for the operator of the hammer to give the signal when the hub was to be removed, so when the signal was given the plaintiff placed his hands under the hammer, when it delivered a second stroke, due to its defective condition, and crushed his hands. Judgment was given in favor of the plaintiff.

In an Indiana case, it was alleged that the valve which is designed to hold the air, by the force and pressure of which air the hammer is held and kept from falling until made to fall by the person operating a lever, was old and defective, allowing the air to escape into the cylinder, which pressure caused the hammer to fall. The evidence showed that the hammer fell of its own weight, but was raised and held up by compressed weight. It was held to follow, necessarily, that a valve which permitted air to leak through to the cylinder would hold up the hammer rather than cause it to drop. For this and other errors, the court reversed the verdict in favor of the plaintiff and ordered a new trial.

* * *

METHOD OF POLISHING SMALL MACHINE PARTS

In many cases the finishing of small machine parts is accomplished by holding the parts in a vise and using a file and emery cloth to produce the required finish. This method is satisfactory for a few parts but the work can be done much more rapidly when a number of parts are to be finished by using wooden rolls, covered with emery cloth and rotated at the proper speed in a small speed lathe. The method of covering these rolls with emery cloth is shown in the accompanying illustration. At *A* is shown the end of a strip of emery cloth cut to the proper shape for covering the roll shown at *B*, the length of the diagonal end, or the distance from *D* to *E*, should equal the circumference of the roll *B*. The end of strip *A* should be fastened to the roll with small tacks in the position shown at *F*. The strip can then be wound tightly about the roll and fastened at the opposite end in the same manner. The appearance of the covered roll is shown at *C*. This method enables anyone to cover a roll easily and quickly, and after a little practice the emery cloth can be wound so tightly and evenly about the wooden roll that it looks like a solid roll of emery. F. C. D.



Covering Wooden Rolls with Emery Cloth for Polishing Purposes

* * *

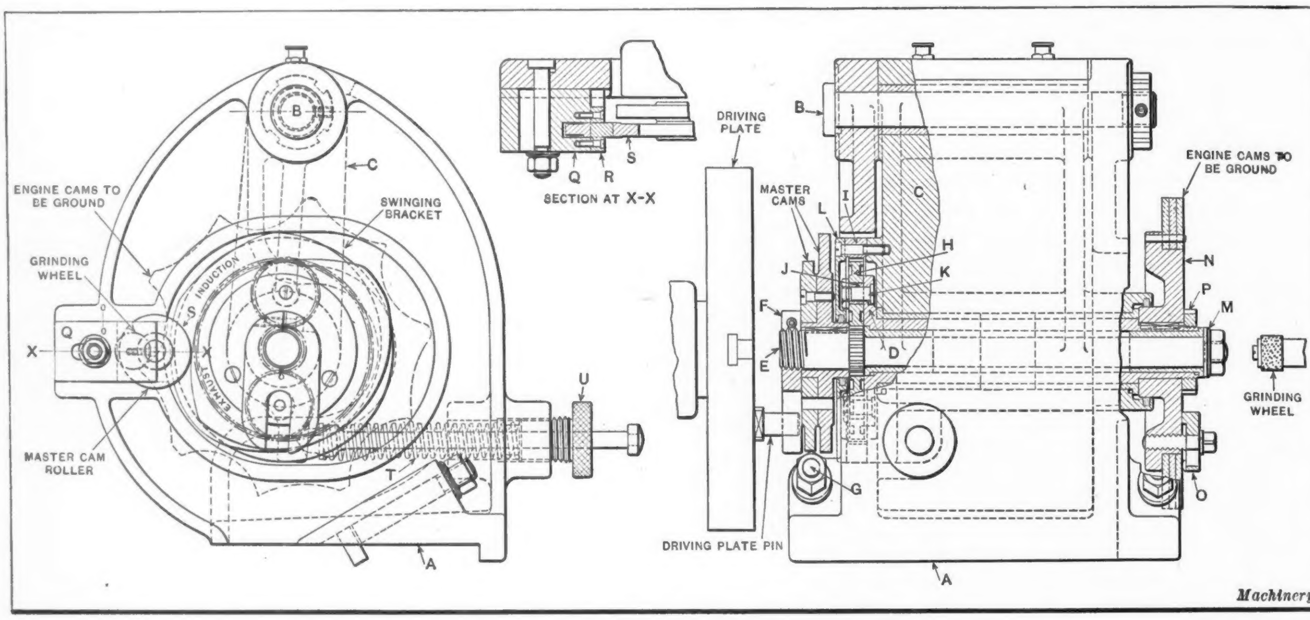
A national trademark consisting of the four letters "S. P. E. S." (Syndicat pour L'Exportation Suisse) has been adopted in Switzerland in order to prevent foreign goods, primarily German, from being passed off as being of Swiss origin. The right to use this trademark is limited to products of the Swiss soil and of Swiss industry, and to goods that have been subjected in Switzerland to such processes of manufacture as to confer upon them a new character. The use of the trademark is limited to native-born Swiss citizens and to those who have been naturalized citizens of Switzerland for at least ten years.

MULTIPLE CAM-GRINDING ATTACHMENT

BY J. LENNARTZ[1]

The multiple cam-grinding attachment shown in the accompanying illustration has recently been patented by the writer. It is designed for grinding multiple type cams for operating the induction and exhaust valves of airplane motors. Some of the characteristic features and advantages of the attachment are given in the following:

Each lobe of a multiple cam is ground with the same master cam; thus all the lobes of the multiple cam will be absolutely alike and of the correct shape. The generating principle which is employed insures greater accuracy and a better finish than does the ordinary forming method. The indexing obtained through epicyclic gearing insures accurate results, and by the use of eccentric bushings the play between the teeth of the gears can be taken up, thus providing for wear. The spindle carrying the master cam and cam to be ground are concentric with the spindle carrying the reduction gearing, which makes the whole mechanism compact and of simple construction. The master cam can be ground in position from a correct motor cam. One of the chief advantages of this attachment is its adaptability to different types of grinding machines.



Multiple Cam-grinding Attachment

Description and Method of Using Multiple Cam-grinding Attachment

As shown in the accompanying illustration, the multiple cam-grinding attachment consists of a stationary body or cage *A* through the top of which passes pin *B* on which hangs the swinging body *C* between the two arms of cage *A*. The lower end of swinging body *C* is bored to receive a hollow spindle *D*. Inside spindle *D* runs a central spindle *E*, both being connected by means of a combination of gears or epicyclic gearing, the ratio of which corresponds to the number of lobes in the cam to be ground. The central spindle *E* carries on the side of the gear one or more master cams, the profile of which corresponds to one lobe of the multiple cam to be ground and which are kept in position by the carrier *F*. Carrier *F* is driven by the pin in the headstock faceplate of the grinding machine. The attachment is fastened to the grinding machine by bolts *G*.

The pinion on central spindle *E* drives the satellite gears *H*, meshing with the stationary internal gear *I*, the latter being concentric with the pinion and fastened to swinging body *C* by screws. The result is that the driven members are forced by the driving pinion to roll around inside the internal gear, thus transmitting a slow rotary motion to the driven spindle *D*. The satellite gears *H* revolve on eccentric bushings *J*, held on the flange of spindle *D* by means of bolts *K*. The purpose of these eccentric bushings is to obtain a perfect meshing without play and to provide for wear by throwing half the satellite gears against the pinion on spindle *E* and the other half against the internal gear *I*. Cover *L* protects the gears and bearing on this side. Central spindle *E* is held inside the hollow spindle *D* by collar nut *M*. On the other end of spindle *D* is keyed a plate holder *N* on which the cams to be ground are located and fastened by clamps *O*. The hollow spindle *D* and plate holder *N* are kept in position in swinging body *C* by slotted nut *P*. Both spindles *D* and *E* run in phosphor-bronze bushings. The lubricators on top of body *C* supply all bearings and gears with oil. Felt washers are used to protect the bearings from flying grit. The stationary body *A* carries a roller holder *Q* opposite the master cams. The roller *S* shown at section X-X turns on the roller pin *R* which is held in the holder *Q*. The master cam maintains contact with the roller *S* under the pressure of spring *T*, the tension being adjusted by nut *U*. By turning the roller holder *Q* over with the roller *S*, the latter is automatically brought in front of the next master cam.

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* * *

WAR, THE MOTHER OF SCIENTIFIC ADVANCEMENT

According to *Engineering*, Professor R. A. Gregory recently stated at the British Scientific Products Exhibition at Kings College, England, that through the efforts of the chemists of England, there had been a revival of the glass industry to the end that a position has been secured strong enough to meet all the demands of English manufacturers. The pure potash required for certain glasses is being obtained by a new electrolytic process, and England need never again depend upon Germany for either the potash or for the glass itself. The demand for synthetic organic drugs, synthetic dies, photographic chemicals, and many similar chemically manufactured substances is also being adequately met. The German magneto has been displaced permanently. Hard porcelain for electrical fittings and laboratory ware is now being produced in England, in addition to all the tungsten required for special steels and metallic filament lamps. Professor Gregory further states that British-made aluminum alloys are superior to any of the German pre-war products. These statements, coming from such a reliable source, are reassuring, especially in view of the rapid scientific and industrial progress that has been made in the United States since the rupture with Germany. This is particularly noticeable in the chemical laboratory.

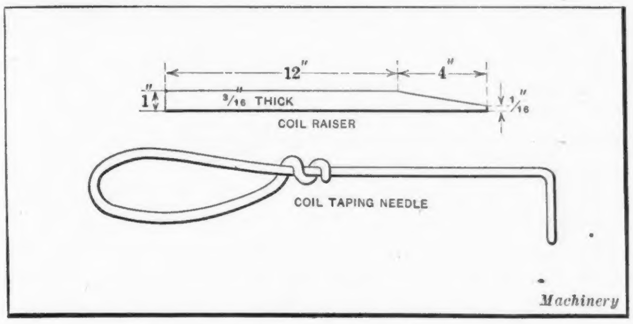

Fig. 1. Coil Raiser and Coil Taping Needle

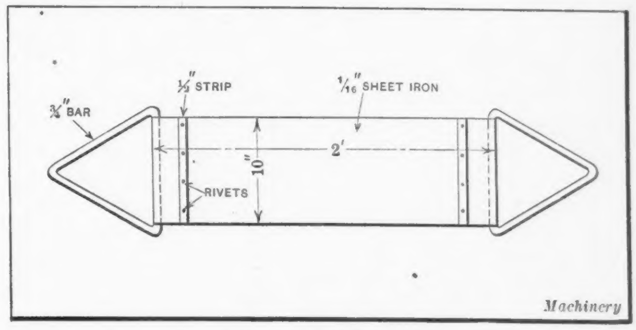

Fig. 2. Armature Sling

TOOLS USED IN ELECTRICAL WORK-SHOPS

BY MAURICE M. CLEMENT[1]

IT is surprising how many homemade tools one can see in an electrical repair shop. Everything from a coil taping needle to an armature banding tension-block can be seen among an armature winder's tools. The fact that none of these tools can be bought ready-made, but must all be especially constructed, gives them an interest that is lacking in standard tools. One of the simplest tools is the "coil taping needle." This is made of a length of No. 14 banding wire as shown in Fig. 1, and as only one foot of the wire is used in making this tool it costs very little. The taping needle is used for taping coils in closed slot stators, and when the workman becomes accustomed to its use, much speed can be attained, thereby saving considerable time. The coil raiser, shown in Fig. 1, is simply a piece of steel, 16 inches long, 1 inch wide, and 3/16 inch thick, with a 4-inch one-sided taper on one end; this tool is used mainly in stripping open-slot armatures and stators, but can also be used to advantage in removing grounded coils from a newly wound armature, or in raising coils sufficiently to allow for insulating a weak spot, the main object being, in this case, to lift out a tight-fitting coil without damaging the insulation.

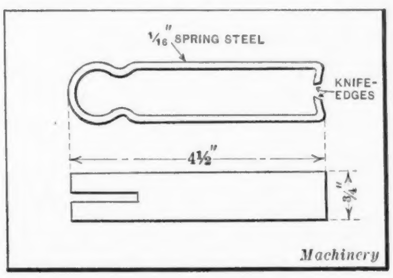

Fig. 3. Wire Scraper

Fig. 2 shows an armature sling, which is made of a piece of 1/16-inch sheet iron, 2 feet long and 10 inches wide; at each end is a steel triangle, made of a 3/4-inch steel bar, for hooking onto a crane; without this sling a rope or wire cable strap would have to be used, with the danger of springing the shaft. In a recent test this sling held a weight of one ton without apparent strain.

The wedge-drift, not shown, is a piece of tool steel 8 inches long, 5/8 inch wide, and 3/32 inch thick, over which is fitted loosely a steel sleeve; the wedge-drift is used for driving fiber wedges between the top of the coil and the lamination overhang in closed-slot machines. To use the wedge-drift efficiently, first insert the fiber wedge about 1/4 inch into the slot; then with the drift pulled back in the sleeve, fit the sleeve over the wedge and drive it to the proper place. The sleeve will hold the wedge in its proper position and prevent breakage.

The wire scraper, Fig. 3, is one of the best time-savers of all. In ordinary circumstances a knife is used to scrape wires prior to connecting, but the rough treatment a knife receives in scraping wires, shortens its life, thus necessitating frequent renewal of knives and incidentally adding to the expense. The wire scraper is made of spring steel, 1 foot long and 3/4 inch wide. Before bending to the desired shape, a knife-edge is ground on each end and a piece 2 inches by 1/4 inch cut out from the center; after bending to the proper shape, the knife-edges can be retouched with a file. The open space which is now at the back end of the scraper gives a greater spring effect and allows the knife-edges to be brought together with a minimum amount of pressure.

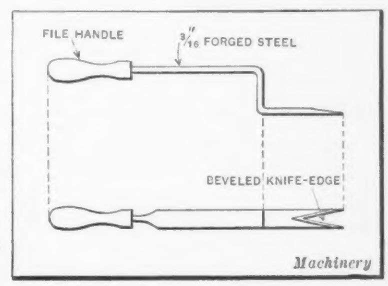

Fig. 4. Cell Cutter

The cell cutter, Fig. 4, is another simple but effective tool. It is composed of a piece of forged steel, 14 inches long, 3/4 inch wide, and 3/16 inch thick, with a set of beveled knife-edges at one end and a file handle at the other. The handle is raised so as to allow free movement of the cutting end. The tool is used in cutting projecting insulation from slots of open slot windings after the coils have been assembled.

In Fig. 5 is shown a cell shaper, which is almost indispensable in any well equipped repair shop. The base of the tool is of hard wood—in this case maple—and it is composed of two pieces, one, 16 by 4½ by 3/4 inch, and the other, 16 by 2 by 3/4 inch. The pieces are hinged together on the long edge. Where they join, a 1/2-inch metal strip is placed, which is shaped at the ends so as not to interfere with the action of the hinges, and is held down by screws; between the hinges, the strip is raised sufficiently to allow the insertion of a piece of fish paper. Behind the metal strip

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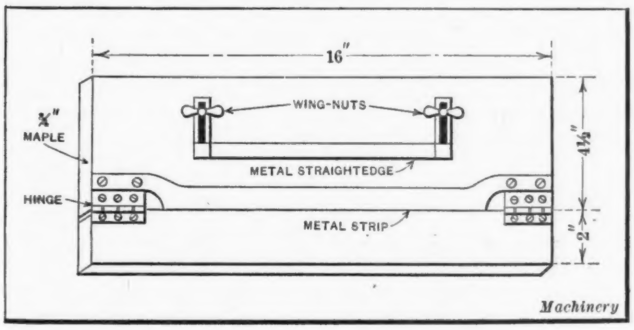


Fig. 5. Cell Shaper

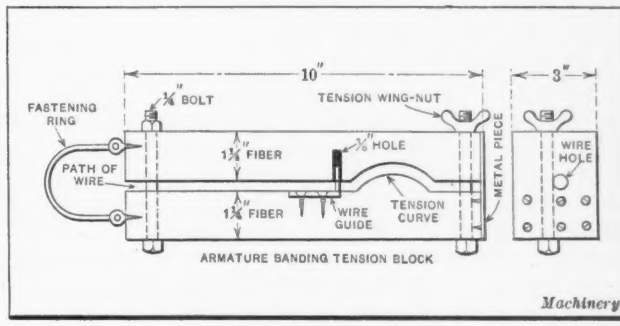


Fig. 6. Armature Banding Tension Block

is an adjustable metal straightedge with wing-nuts to hold it in place. To make a cell for a closed slot stator or armature, the length of the slot must be first determined, allowing for a short projection; next the height of the slot, measuring from the bottom of the slot to the bottom of the lamination overhang, and then the width of the slot at the bottom. This gives the following:

Length of slot + projection = one dimension. Height of slot × 2 + width at bottom = the other dimension.

In cutting the fish paper for these cells, the grain of the paper must be taken into consideration; the right way to cut it is to lay out the first dimension with the grain and the second across the grain. In adjusting the cell shaper, the distance from the forward edge of the metal strip to the metal straightedge should be equal to the height of the slot. To shape the cells, insert the fish paper under the metal strip until it is squarely against the straightedge, and turn the hinged base on the hinges; this will make a neat fold in the paper. Then turn the paper around and make another fold on the opposite side.

In the small shop, where the armature winder does his own banding, the armature banding tension block shown in Fig. 6 will be found of value. The tension block does away with the necessity of using a banding lathe. The armature does not have to be removed from the stand to be banded. About one foot of stout line with a hook lashed to one end is secured to the fastening on the tension block and hooked to an eyebolt which is set in the floor for that purpose. The spool of banding wire is placed on a small stand beside the eyebolt, after which the wire is passed between the two blocks at the rear end, through a hole in the first wire guide, over the tension curve, through a second wire guide hole, and thence to the armature. The tension can be regulated by the wing-nut at the forward upper end of the block. By screwing down the wing-nut, both sides of the block are brought together, thereby narrowing the tension curve over which the wire must pass; this increases the resistance on the wire and, incidentally, the tightness of the band. A pipe-wrench is used on the shaft to revolve the armature. It will be noticed that the forward end plate is screwed to the lower half only, so as not to interfere with the tension wing-nut and bolt.

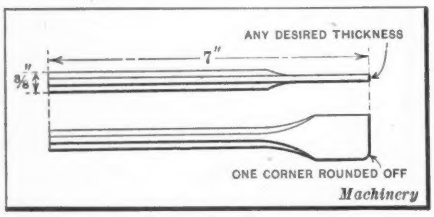


Fig. 7. Driving-down Tool

The driving-down tool illustrated in Fig. 7 is merely a thin-bladed chisel with the end squared off, and is used for driving down leads into commutator slots. It is advisable to have four or five chisels with blades of various thicknesses for use on different sizes of wire.

* * *

ELECTRIC STEEL PRODUCTION

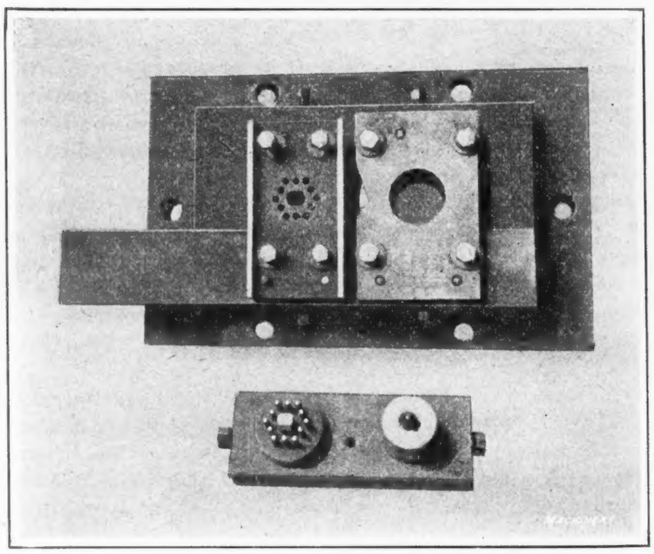
The Illinois Steel Co., South Chicago, Ill., has the largest electric steel plant in the world and it is expected that its production will be 200,000 tons of electric steel ingots annually or nearly as much as was produced in 200 electric furnaces in 1917. In 1909, only 13,700 tons of this steel was made in the United States as against 500,000 tons estimated for 1918. On the first of January of this year, we were credited with 233 furnaces, Great Britain with 131, and Germany with 91. By the end of this year it is probable that there will be 300 electric steel furnaces in the United States. This product might appropriately be named "war steel," since the demands for war material more than anything else have resulted in this great increase of the production of a scientifically manufactured steel. It has been demonstrated that rails of electric steel are tougher and of greater ductility than either the Bessemer or open-hearth rails.

NOVEL METHOD OF MAKING DIES

In the accompanying illustration is shown a punch and die designed by Mr. Rollman of The New Standard Hardware Co. of Mount Joy, Pa., for use in making one of the parts of a food chopper. The most interesting feature of this device is the piercing punch and die shown at the left. The method employed in holding the small punches is novel and one that may be used to advantage in constructing punches for doing various kinds of light punch work. In making this punch and die, the stripper was first made, using stock slightly thicker than is customarily used for this purpose. Special care was used in laying out and drilling the holes so that they would conform to the exact measurements required. After the stripper was finished and hardened it was used as a templet for drilling and finishing the dies and also for drilling the punch-holder.

The large central punch was securely fastened in the holder in the usual manner. The twelve small punches surrounding the central punch, however, were provided with enlarged heads and inserted in their respective holes in the punch-holder, from the rear. The holes in the punch-holder were made slightly larger than the punches. The small punches were, therefore, loose in the holder, but were prevented from falling out by the enlarged heads which fitted into counterbored holes. The stripper plate was then carefully aligned with the die and securely held in position.

In operation, this punch is set up in the usual way. The small punches are guided by the holes in the stripper plate, which are slightly beveled at their upper edges; thus the holes in the stripper plate serve to compensate for the slight looseness in the punches, bringing them into exact alignment with the holes in the die. It will be seen that the stripper plate in this case has an action similar to that of a sub-press, and the entire construction enables the punches to be more easily assembled and eliminates considerable fitting. The punches are all made of annealed tool steel and are hardened in the usual manner. It has not been found necessary to restrain the small punches against movement during the grinding operation, they are simply set up and ground the same as punches which are rigidly secured in the holder. This type of construction interferes in no way with the usual operation of the punch, and stock equal in thickness to the diameter of the punch can be easily pierced.



Punch and Die used in making Parts for Food Chopper

* * *

Since 1914, there has been a great increase in the use of water power in France, principally for the manufacture of large-caliber shells and armor plate. The development of 180,000 horsepower on three rivers near the Alps will, after the war, enable France to produce chlorine, bromine, magnesium, etc., which was formerly obtained from Germany.

THE EMPLOYMENT WINDOW

BY RUSSELL WALDO[1]

That the selecting of employes at a window of the plant is an injustice to the applicant as well as a loss to the employer is acknowledged by many firms who have established the method of personal interview. A prospective employe does not feel free in speaking before a crowd of other prospective employes which is usually found at the window of the average shop. The modern manufacturer recognizes this, and he has found that in the majority of cases the most efficient employes are those who are interviewed behind a closed door, or at least away from the group which is usually assembled. An applicant does not object to being interviewed before the staff of the employment department, although he will not feel free to answer the questions which are asked before strangers who are in no way connected with the firm.

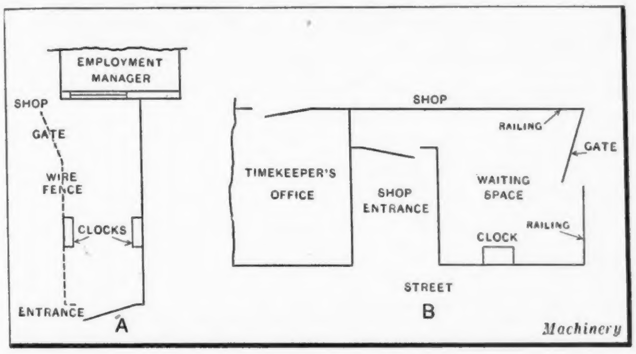


Fig. 1. Two Examples of Poorly Arranged Employment Offices

The disadvantages of interviewing an applicant before a window in the presence of several other applicants is fast being overcome. Some have modified their methods, some have made radical changes, while others have held to their former ideas. It was the writer's privilege a short time ago to have the opportunity of taking this matter up with one of the directors of an organization which employs about two thousand employes and which expects in the immediate future to enlarge its plant so that it will employ at least three thousand persons. During this interview the director asked the writer to submit to him a plan for a modern employment office which could accommodate the number of applicants which they expected to receive. Previous to this time they had been using the window method, and he felt that this method was unfair in many ways and believed it his duty to correct it. The plan was given to him with an explanation as to why certain suggestions were made. In this plan the waiting room was separated into two parts, one for the women and one for the men. It also had provision made for a personal interview for each and every person who applied for a place. One of the advantages of the personal interview is that more reliable and complete information will be given by a prospective employe concerning his experience and former places of employment.

Inefficient Methods of Selecting Employes

The accompanying illustrations show several methods which have been used in interviewing applicants. Fig. 1, at *A*, illustrates a very inefficient method of selecting employes. The hallway will only accommodate about ten at the most. All others must remain outside, and if it is raining, this proves most uncomfortable. This hallway is also used for the girls' entrance to the plant. At one end, as shown, is a window where the employment manager interviews all the applicants. If they claim to possess the requirements, he passes them through the gate to the watchman, who accompanies them to the department head for further interview. The writer knows of several who have applied for work where this method was used and who would not speak freely because of the publicity of the matter. By placing a door where the window is located, each applicant could be personally interviewed and more reliable information could be obtained.

Another badly arranged employment division is that which has its office located within the plant at the very entrance. In front of this window scores of applicants often gather in the morning and actually obstruct the passage for the employes. In this case the applicants are interviewed before an open window. After the interview they enter the employment superintendent's office to sign their papers if they are going to work. It would be far better to call the applicant into the office at the beginning.

In another plant in which the conditions could easily be improved, the applicant, as in the two preceding cases, is interviewed before an open window. If accepted, he is then taken through the factory door into the employment office where he must sign his papers. In this case no one except applicants are in the waiting room. Rearranging this employment office interior and placing a door where the window now is, would greatly facilitate the interviewing of applicants. Even if the door were made with the upper half a screened panel, it would make the situation far better. The employment manager could admit employes without going through the factory to do so. This is both unhandy and inefficient.

The arrangement shown at *B*, Fig. 1, is poor in every respect. In the waiting space is the time clock, and every morning applicants stand within this space, making it necessary for employes to crowd through. There is only a railing around the space, and the machine shop is on the other side of this railing. Each foreman in need of men for his department comes here, and if he sees a promising applicant he calls him to the railing and talks to him there, where the entire conversation can be heard by those around them. Wages are arranged there and the applicant is not admitted through the gate until the foreman has accepted him; then he is taken to the timekeeper's office, where he must sign a card before he goes to work. There is no remedy for this except to erect an office outside of the building where applicants may be interviewed.

One employment office within a building only a year old, which has been constructed by a firm that employs three or four thousand persons, is so arranged that the applicant is interviewed by the man in charge of the tool-room while he stands within the employes' passageway. The interviewer is often interrupted by employes who come for tools. This arrangement is, therefore, far from economical, and it would

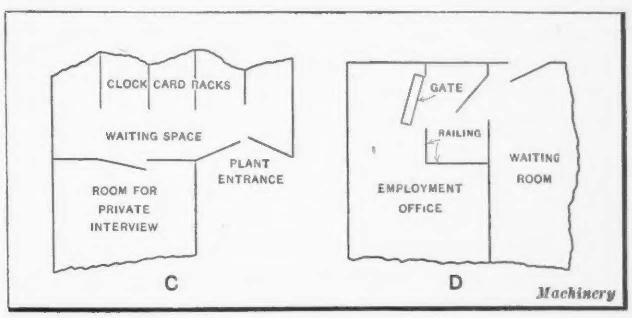


Fig. 2. Two Examples of Well-planned Employment Offices

be more profitable to partition off a small room from the tool-room for the timekeeper, who could look solely after the the employes' interests.

Efficient Methods of Interviewing Applicants

At *C*, Fig. 2, is an arrangement used by a plant which has been doing business for thirty years. In this case there is a watchman at the door who allows no applicant to enter until five minutes after the whistle has blown. Outside there is a cover for shelter from rain. At the proper time the watchman admits the waiting applicants. From here the employment supervisor admits the applicant into a side room for a personal interview and to make out the application. Regardless of who the man is or whether there is a possibility of

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using him at once or not, he is admitted for a personal interview. In the event of an urgent need for a special workman, the employment supervisor often calls to the waiting applicants for one who can fill the place. This system has been installed in this plant for about twenty years, and the employment supervisor has records showing comparatively small labor troubles, which may be due largely to the personal interview which is granted every employe.

At *D*, Fig. 2, is a remodeled employment department. No more than two are admitted into the employment office at one time. A clerk meets each employe before the gate and fills out a blank form containing the minor questions. This clerk then refers the applicant to the employment manager for detailed consideration. This system has been in use about two years, and the employment supervisor claims greatly improved results because of it.

* * *

SAFETY, HYGIENE, AND WELFARE WORK IN A MODERN FACTORY

BY FRED H. KORFF[1]

Much has been written about safety, hygiene, and welfare work in the modern factory and many methods for carrying on this work have been devised. The method here given has proved very satisfactory in the plants where it has been used, due to the efforts made to secure the cooperation of all the employes. Having as many as possible serve at different times on the various committees causes them to take an active part in the work and also gives each one an opportunity to present his views on the subject and suggest plans for the improvement of the general factory conditions.

The work is under the direction of the General Factory Committee, which consists of representatives of all the employes, both the heads of departments and the operatives. This committee meets often and makes frequent reports to the management. It carries out its plans with the aid of subcommittees, one for each department of the plant, consisting of employes chosen by the General Factory Committee from the employes of the department that each subcommittee represents. These subcommittees meet as often as the General Factory Committee, although at a different time, and their personnel should be frequently changed. In one case in which this method has been adopted, the General Factory Committee consists of nine members, who are chosen for a period of six months; it meets on the first Monday and second Friday of each month. The subcommittees are appointed to represent the toolmakers, machinists, carpenters, coppersmiths, millwrights, electricians, and the specialists employed in the plant. Each subcommittee consists of three members chosen for two months, and meets on the second Thursday and last Saturday of each month.

Welfare Work

At its meetings the General Factory Committee should discuss the housing, food, safety, general shop conditions, matters of general interest, and subjects submitted to it by the management from time to time. Plans should be discussed and formulated for the betterment of the employes' moral, mental, and physical conditions. This does not mean obtaining a detailed analysis of each person throughout the plant, but developing methods for bettering the general conditions of all. Investigations should be made relative to hygiene, the employes' physical condition, their surroundings, and the sanitation of the factory; too little effort is expended along these lines. A little time spent in assisting an employe to live properly and to have the proper surroundings while at work is a great asset to a company.

The housing problem should be gone into carefully. If a man must travel from an hour to an hour and a half to reach his place of employment, he becomes tired before beginning work and his effectiveness has been decreased. The home environments of the employes should be investigated.

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As employes in the average factory spend the greater part of the time that they are awake at their place of employment, conditions should be made as nearly ideal as possible. Cleanliness, light, heat, and adaptability to the working conditions should be investigated and tests made in the different departments to determine what will or will not benefit the employes. No detail, however small, should be overlooked, for it is the small things that tend toward greater efficiency. Employes should be taught to keep all aisles free from rubbish, waste, etc. Receptacles should be provided for holding debris, and these should be emptied daily by porters who should also keep them in a sanitary condition. The porters should also take care of lavatories, etc. If the division heads and foremen will impress on the careless employes the fact that they are spending a large part of their lives in the factory, their attitude toward cleanliness, carefulness, and thoughtfulness may change. With the proper environment, they will be imbued with the determination to do the best possible work of which they are capable.

Napoleon Bonaparte once said that his army was like a snake in that it marched on its stomach, meaning that if the soldiers were properly fed they would take care of the rest. The same applies just as well to an army of employes whether they are skilled or unskilled. Men or women in any class of work must be properly fed or they cannot satisfactorily perform their duties. The kind of food employes can purchase at the noon hour should be thoroughly investigated and, if possible, the services of a chemist or dietitian should be obtained. The aim should be to have the factory filled with employes who do not have to worry about the amount and quality of food they receive, nor about any ill effects it may have on them.

Safety Measures

The expression "Safety First" has become a nation-wide slogan; this was originated as a catch word and applied to the safeguarding of the lives of employes in various factories. Its conception was a great aid in advancing the idea of safety throughout the country. The fact should be borne in mind, however, that words alone cannot prevent accidents; prevention requires the installation of the proper apparatus and the guarding of moving belts, gears, etc. Investigations relative to the safety factor should include the smallest detail, and methods should be devised whereby each unit will be thoroughly analyzed in order that the best means for preventing accidents may be ascertained. Each employe must keep his mind on his work. He cannot do proper or safe work if he is carrying on a conversation or fooling with someone. Concentration at all times is the fundamental rule of safety in any factory.

* * *

According to an agreement made with the War Industries Board, only one-fourth as many pleasure automobiles will be made during the last half of this year as were made in the corresponding period of 1917. The manufacturers will be furnished with the material necessary to complete the agreed number of cars, but any excess stock, unless it is needed for war work, must be turned over to other plants that require it. It has been estimated that the various plants have $150,000,000 worth of raw and semi-finished material on hand, and this cannot be used until it has been "matched up" with the materials necessary for completing the cars. By stopping the production of passenger cars, 800,000 tons of high-grade steel will be saved at the works of the Ford Motor Co. alone.

* * *

In experiments conducted by W. E. Alkins, of Manchester, England, according to *Engineering*, it was found that if fully annealed copper wire of any diameter is drawn down, when the area of the wire has undergone a reduction of about 50 per cent over a limited range further drawing causes no corresponding alteration in properties. Moreover, the physical properties corresponding to this constant change are always the same. The density is 8.889, the specific volume 0.11251, and the tensile strength about 23 tons per square inch.

A PRACTICAL RING, PLUG, AND SNAP GAGE SYSTEM

DETAILS OF A GAGING SYSTEM IN WHICH THE REQUIREMENTS IN INTERCHANGEABLE MANUFACTURE HAVE BEEN MET

BY C. J. FISCHER[1]

THE following is a description of a gaging system embodying the principles set forth in the article "Developing A Gaging System," that appeared in the October number of MACHINERY. While the methods of applying these principles may vary in some of their minor details, they would always be essentially the same in their more important features.

Classes of Gages Required

To insure the accuracy of the product, three classes of plug, ring, and snap gages are necessary. Each of these three classes will be referred to in the order of their application. Gages of the first class are used by workmen at the machine who inspect the product from time to time. The tolerance allowed by a gage depends to a certain extent on the length of time the gage has been in service, but when the workman's gage is new it allows about 80 per cent of the actual tolerance of the product, as shown in Fig. 2. By allowing but 80 per cent of the actual tolerance on the workman's gage, it can wear considerably before being resized or replaced, besides doubly insuring the acceptance of the product by the inspection department. A workman's gage is accordingly called a working gage.

After leaving the production department the product enters the inspection department. Here each part is inspected by the inspectors whose gages, when new, allow about 90 per cent of the actual tolerance allowed on the part to be gaged. Fig. 3 illustrates gages of the class used by the inspectors. Gages of this class are called inspection gages.

It is often found necessary to reinspect the product to decide disputes arising between the producer and the purchaser. Especially is this the case on government or other large manufacturing contracts where parts are manufactured in one plant and assembled elsewhere. In the case of a dispute a gage of the third class is indispensable. This class consists of gages which allow precisely the full tolerance allowed on the part. A set of this class is held in reserve for an emergency and these gages are called master inspection gages. These are shown in Fig. 4.

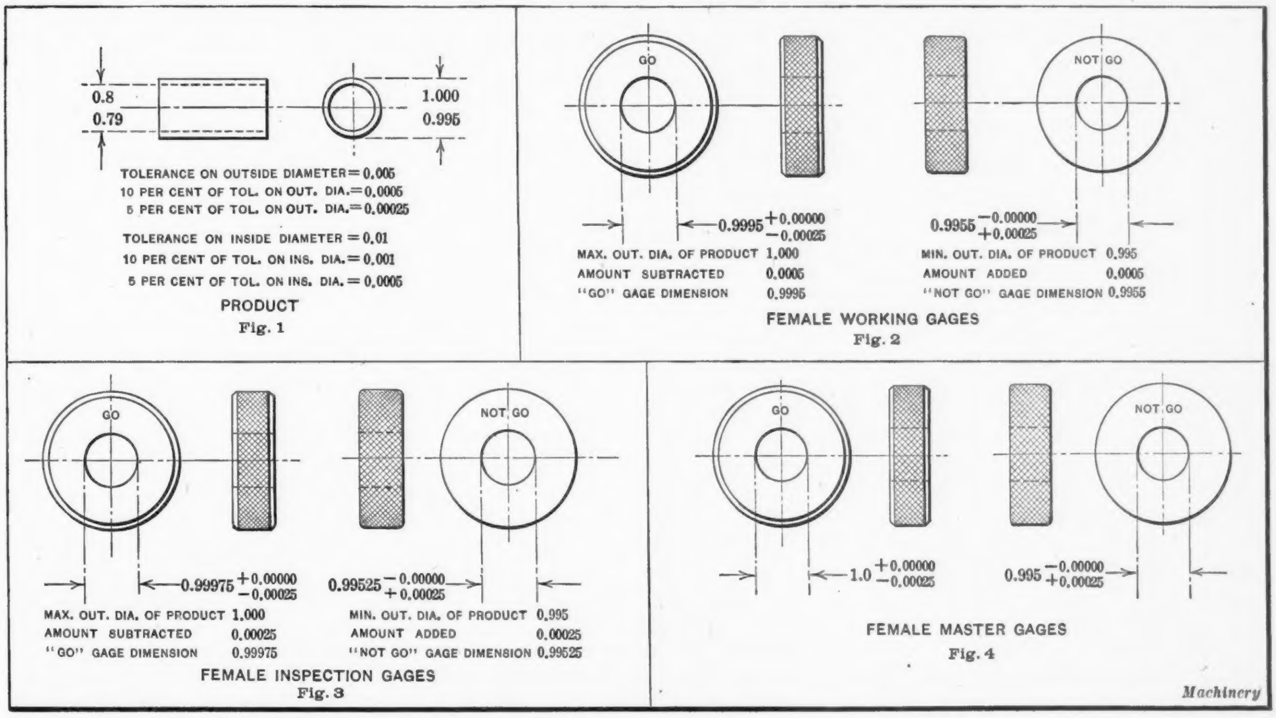

Fig. 1. Tolerance allowed on Work. Fig. 2. Female Working Gages. Fig. 3. Female Inspection Gages. Fig. 4. Female Master Gages

Determining Gage Dimensions

Figs. 2, 3, 5, and 6 are accompanied by calculations showing how the respective gage dimensions are determined. Working gages, Figs. 2 and 5, allow but 80 per cent of the actual tolerance, a 10 per cent reduction being effected by a change in the maximum dimension, and an additional 10 per cent reduction by a change in the minimum dimension. Inspection gages allow 90 per cent of the actual tolerance, a 5 per cent reduction being effected by changes in each of the two gaging dimensions. In determining the "Go" and "Not Go" gage dimensions, the respective per cent of reduction (if working gages 10 per cent and if inspection gages 5 per cent) is added or subtracted, which is determined by the following rules:

Rule 1—For "Go" male and "Not Go" female gages, add the respective per cent of the actual tolerance to the part dimension.

Rule 2—For "Not Go" male and "Go" female gages subtract the respective per cent of the actual tolerance from the part dimension.

Rules 1 and 2 cannot be applied to the outside and root diameters of "Not Go" thread gages. In this case the outside and root diameters are the same as the "Go" gages, the effective or pitch diameter only being subject to Rules 1 and 2.

Gage Manufacturing Tolerances

It is essential that the manufacturing tolerance for gaging dimensions be given on gage drawings so that those who order gages have a definite basis on which to reject them if necessary and also to insure the amount of service to be received from the gages. The day is past when the gagemakers' veracity is allowed to be questioned. Attention is called to the gage manufacturing tolerances as shown in Figs. 2, 3, 4, 5, 6, and 7. One-thousandth inch is the max-

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imum gage manufacturing tolerance allowable, but when the tolerance on the product is less than two-tenths inch the gage manufacturing tolerance is 5 per cent of the tolerance allowed on the product. On the "Go" gages it is applied so that if the manufacturing tolerance is entirely taken advantage of by the gage-maker the life of the gage is lengthened. On the "Not Go" gage, however, the tolerance is applied in the opposite direction from that of the "Go" gage. If the "Not Go" gage has its manufacturing tolerance applied plus, the manufacturing tolerance will be applied minus on the "Go" gage. If the tolerance were applied in the wrong direction on the master inspection gages they would pass parts which should be rejected.

The results of applying the manufacturing tolerance in different directions are shown in Fig. 8. In this illustration

Thread Gage Manufacturing Tolerances

In applying the manufacturing tolerances to thread gages, Rules 3 and 4 apply with the exception of the root and outside diameters of "Not Go" thread gages which should be the same as the corresponding diameters of the "Go" gages. The great improvements made in thread gage making and measuring facilities have made it possible to hold the angle and lead within tolerances that easily suffice for all practical purposes. A variation in lead of ± 0.0002 inch in a distance equal to the effective length of the thread on either the male or female part to be gaged, depending on which is the shorter, will suffice for all practical purposes. The nut shown in Fig. 9 is to be gaged by the gage represented in Fig. 10. Here the application of lead tolerance is illustrated. It should be noted that plain plug gages, which do not appear in the

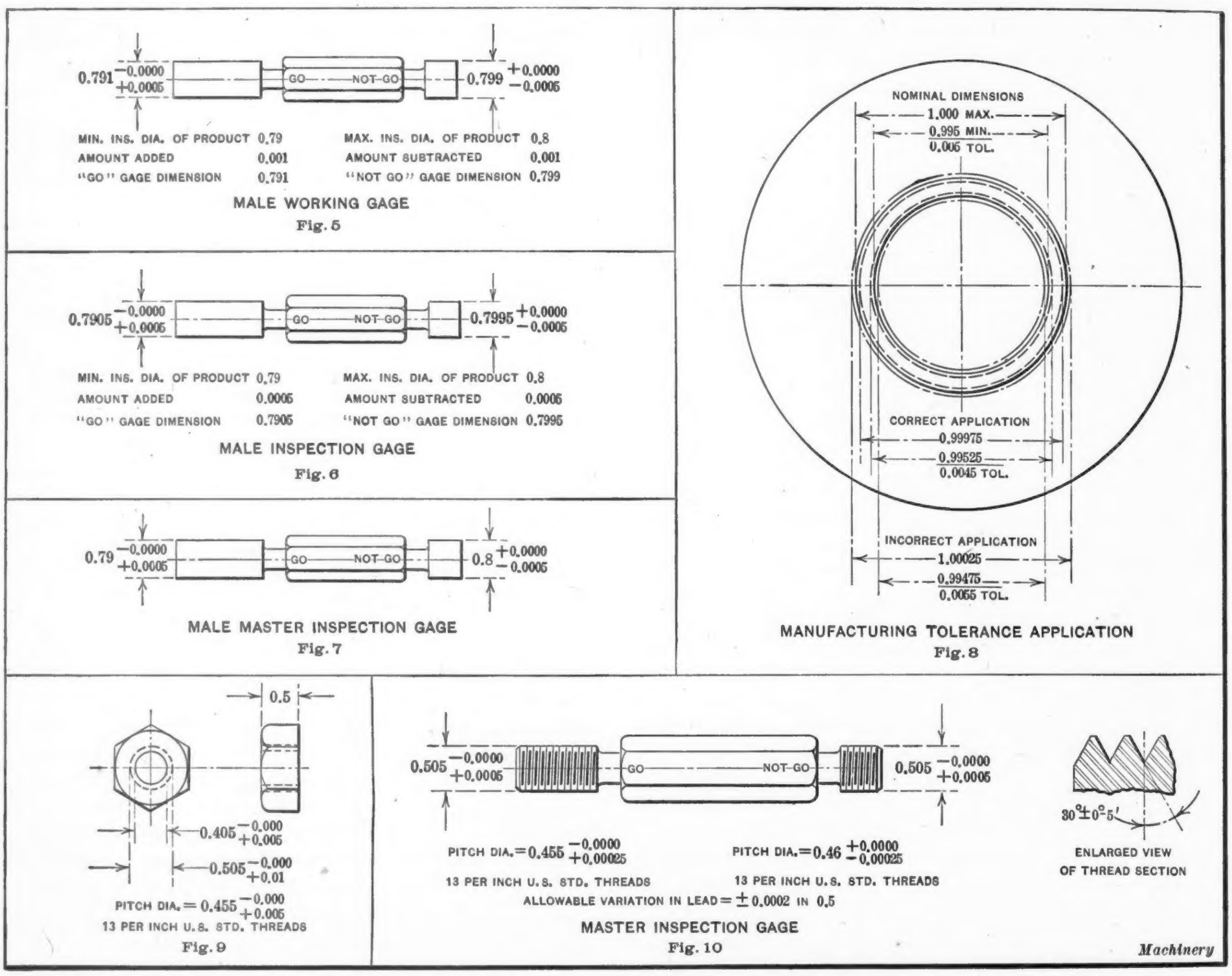

Fig. 5. Male Working Gage. Fig. 6. Male Inspection Gage. Fig. 7. Male Master Gage. Fig. 8. Manufacturing Tolerance Application. Fig. 9. Tolerance of Threads. Fig. 10. Master Inspection Gage

the "Go" female gage is shown placed on top of and concentric with the "Not Go" female gage. The solid circles represent the maximum and minimum dimensions allowed on the part. The dotted circles represent the gages made to drawings on which the manufacturing tolerances have been applied correctly. The dot-and-dash circles represent the gages made to specifications where the tolerance has been applied incorrectly. It is evident that the incorrect application of this tolerance can result in the passing of parts whose actual dimensions are not within the prescribed limits.

If the following rules are adhered to in applying the manufacturing tolerances to drawings of any of the three classes of gages, no difficulty will be experienced.

Rule 3—Apply the gage manufacturing tolerance minus to "Go" female and "Not Go" male gages, outside and root diameter of "Not Go" thread gages excepted.

Rule 4—Apply the gage manufacturing tolerance plus on "Go" male gages and "Not Go" female gages, outside and root diameters of "Not Go" thread gages excepted.

illustration, will gage the nut at its root diameter. Also that the function of female thread gages is to test the part mainly at the pitch diameter, leaving the outside diameters to be gaged by plain ring gages.

For the angle of thread, a gage manufacturing tolerance of ± 5 minutes on the 30-degree angle formed by the side of a thread with a line perpendicular to the axis of the thread, as shown in Fig. 10, is sufficient for all practical purposes. Roots of threads on plug gages and tops of threads in ring gages are preferably made to sharp 60-degree vees, as this will not reduce the value of the gage but will facilitate making the gage, especially in the grinding operation.

Summary

No reference is made in this article to gages used for setting up machines or for inspecting gages of any of the three classes referred to, because the former are not strictly speaking production gages and the latter are now substituted by measuring devices used by the gage inspectors to whom

all gages should be submitted at regular intervals after they have been in service.

The writer is in contact with some of the most elaborate as well as the most simple of gaging systems and has been in a position to study and note the merits or shortcomings of both. The elaborate systems usually include a superfluous lot of gages for checking other gages and the consequence is that the slightest revision in dimensions is very costly from a gage equipment standpoint. On the other hand, if too few gages are available many pieces will go to the scrap heap, justly or unjustly, depending on the accuracy of the workman's gage in the first case, and whether or not a good set of master inspection gages are used for reinspecting in the instance of disputes, in the second case. Manufacturers who are at present using the three-class system as outlined herein and those who will adopt this system will benefit by the experiences of others.

* * *

ACCURACY OF WORM-GEARS

BY OTTO ABDT

There is considerable unwarranted prejudice concerning worm drives, due, among other things, to the mistaken belief that a worm drive will not produce or maintain the correct ratio between worm and worm-wheel unless both the worm and wheel are absolutely accurate. Fig. 1 shows a worm-driven reduction transmission between the shafts *A* and *N*. Shaft *A* is driven by a motor *M* through the miter gears *D* and shaft *E*, which transmit motion to the worm *O* and worm-wheel *P*. Shaft *B* carries the cam *F*, which must rotate in a definite relation to shaft *N*; this relation is determined as follows: The head *L* has a definite number of fingers *K*, to be depressed successively by a push-rod *H*, actuated by cam *F* as the head *L* is rotated in the direction of the arrow.

The push-rod must push in one finger *K* and return and push in the next as the head rotates. Of course, allowance must be made for slippage between the contact surfaces of the push-rod and the fingers in order to avoid introducing intermittent motion of the head *L*. Cam *F* must have a certain exact rate of rotation in relation to shaft *N*, depending on the number of fingers in the head *L*. This means that the ratio of the worm-gear unit must be correct, and it must remain so indefinitely; otherwise the arrangement will not operate.

For convenience, it will be assumed that 24 : 1 is the

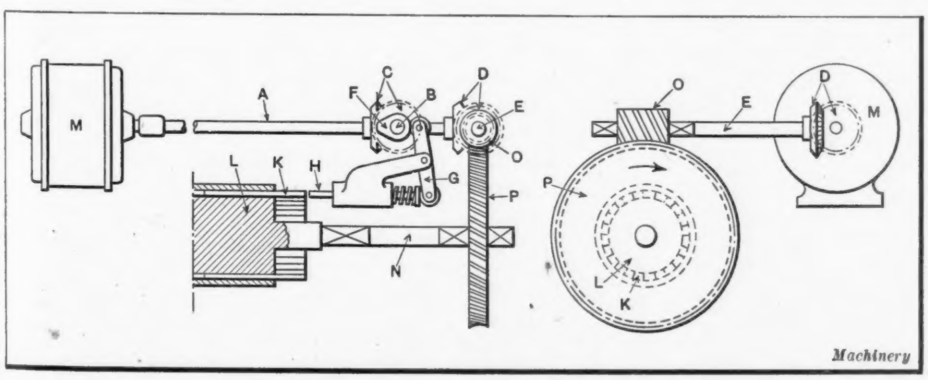

Fig. 1. Worm-gear Reduction Mechanism

ratio required in the worm drive; also that cam *F* revolves at the same speed as shaft *A*. This means that there are twenty-four fingers *K* in the head *L*. It follows, then, that for every revolution of shaft *N*, the cam must revolve twenty-four times.

The objection to adopting a worm drive for a condition of this kind is the difference which is supposed to exist between the actual pitch of the worm and the theoretical pitch. This difference is believed to cause a change in the ratio of the worm unit, due to the variable angle of the worm thread. It is held that with as small a variation as 0.0001 inch from theoretical exactness it would be but a very short time before the push-rod *H* would advance or retard a sufficient amount in its time to set the whole mechanism out of time. If the error amounts to 0.0001 of the pitch of the worm and the pitch happens to be 1 inch, the push-rod, theoretically, will gain or lose one finger at every ten thousand revolutions.

Fig. 2 explains this supposed condition more clearly. Here line *X* represents the path of the worm tooth in a theoretically correct worm. The pitch of the worm is represented by the spaces 1, 2, 3, etc., and the path of a worm (under actual working condition) in which the error of pitch is known to be *D* is represented by the line *Y*. Then for the first revolution of the worm this pitch will advance the

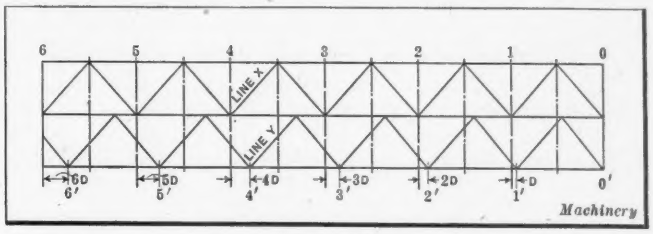

Fig. 2. Diagram of Path of Theoretically Correct Worm Tooth and Path of Worm Tooth under Actual Working Conditions

worm-wheel the theoretically correct distance minus this error. On the second revolution the worm-wheel will fall behind another amount equal to *D*, and so on, gradually losing the exact ratio it was intended to maintain.

But this is a case where theory does not apply to the practical side of the problem, inasmuch as the teeth on the worm-wheel are definite and fixed, and hence there is no path for this progressive difference in pitch to take place between the teeth. It must, therefore, be absorbed there by the crowded action between the teeth of the wheel and the worm. If the error is great, there will be the familiar trouble of cutting. The ratio, however, always remains the same as the ratio for which the unit is laid out. The whole matter, therefore, is rather academic in its nature, and has little bearing on actual practice.

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EFFECT OF WAR ON ENGINEERING SCHOOLS

Because of the war, attendance at the engineering schools of the country has fallen off about 35 per cent, and in some cases as much as 40 per cent. Many third- and fourth-year students as well as instructors have entered military service, and all institutions have suffered financially from the reduced enrollment and higher cost of operation; in the case of one institution this loss amounts to $300,000. However, during the past summer the engineering schools trained over 100,000 national army men as gas-engine workers, automobile repairers, truck chauffeurs, blacksmiths, carpenters, machinists, concrete workers, radio operators, and in other crafts. These men were then assigned to army units, so that each division had a complete complement of mechanical men when it went overseas. New York University, which was one of the first institutions to contract for the technical training of army men, trained 1800 of these men. Because the present facilities are inadequate, the university is now preparing to erect a new building for the School of Applied Science. At the reopening of the various schools this fall, most of the students wore khaki. Out of an enrollment of 2500 at Princeton, only about 300 are taking the purely academic courses.

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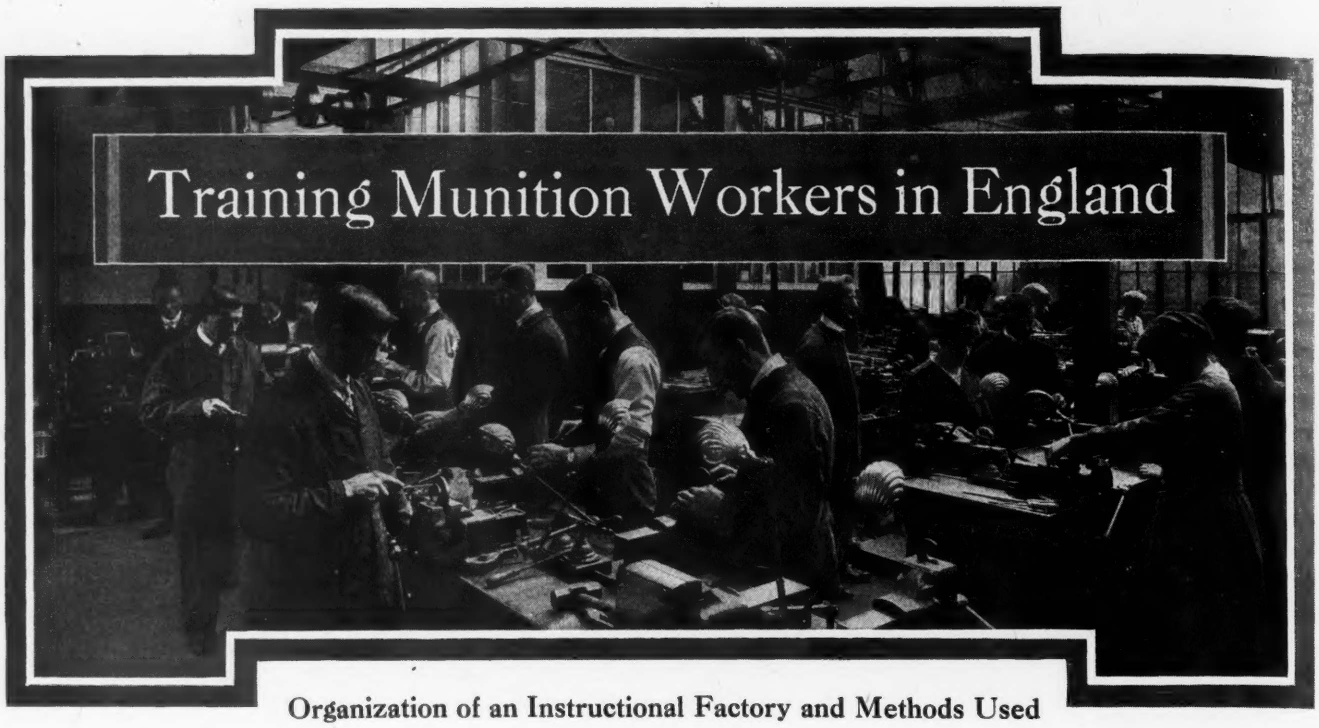
The Motor Transport Corps of each American Army will contain 154,747 men, 40,803 trucks, 24,250 motorcycles, 7905 passenger automobiles and 6598 ambulances.

Training Munition Workers in England



Organization of an Instructional Factory and Methods Used

BY H. SCHOFIELD

Principal of the Technical College, Loughborough, England

ONE of the first difficulties experienced at the beginning of the war, when a considerably increased output of munitions coincided with an extensive withdrawal of men to the fighting forces, was the question of the possible dilution of the engineering trades with woman labor. There were, of course, entire sections of engineering practice in which there had been no thought of attempting to employ any other labor than skilled men. There were also large branches of the engineering industry where the comparatively restricted output in the matter of armament supplies made the jobs largely of a specialized nature, but when the output was considerably augmented, these were brought within the scope of what is now generally recognized as repetition work.

Methods in Use for Training Workers

Prior to the outbreak of the war, there was no supply of suitable woman labor in England to be called upon for the necessary dilution in engineering factories, and consequently schemes were brought forward for the necessary training of such labor in establishments especially equipped and organized for that particular purpose. These establishments roughly group themselves into two distinct sections: (1) The engineering departments of technical colleges and institutions which, prior to the war, were utilized for so-called "practical" engineering instruction. These work-shops were under the charge either of the principal or a member of the engineering staff of the institution whose actual mechanical engineering experience was in many cases nil, or of an antiquated nature. The equipment in the shops themselves was often entirely out of date, and not in the least suitable for the type of training required. This, of course, was not always the case, but it was true in the majority of the technical institutes in the United Kingdom. (2) Engineering work-shops, generally called instructional factories, which were built and equipped purely with the idea of training semi-skilled labor. As a rule, they were equipped with the latest type of plant and machinery, and also with a view to intensive methods of training. These instructional factories were organized upon a productive basis, so that the students, or, as they are now generally called, trainees, were brought into touch as nearly as possible with works conditions from the start. In the former type of institution, the academic influence was paramount, while in the second type there was a strong tendency to make the productive influence much the stronger.

Staff of Instructional Factory

It is difficult to obtain a suitable staff who will include the proper relative amounts of academic and productive instruction. On the one hand, the trainee is most carefully taught by school methods, which are often designed rather to train and stimulate general thought than to give manual dexterity, while on the other hand, in the instructional factory, the nature of the work leads the head of the department naturally to give more attention to the completion of his contracts by the specified date than to the essential organization and training of the workers upon the particular machines required.

As has already been stated, a judicious admixture of the two systems is obviously the better, because we must take it as an axiom that the trainee should leave the instructional factory and enter the works "without shock," whereas, unless the instructor or foreman has clearly before him the necessity of giving adequate explanations, there is a tendency for the trainee merely to become a mechanical operator of a particular series of handles or implements. The instructional factory, or the technical college engineering work-shop, can never hope, of course, to give that essential possession of a fully qualified engineer—experience. This only comes through time and lengthy observation, and while it is true that the immediate requirement is simply a knowledge of the operation upon which the man or woman is to be placed, yet, if this knowledge can be augmented by some general idea regarding the purpose of the operation, it will be possible, unquestionably, to produce a much more successful operator.

The need, then, is to produce a worker fully competent to perform the operation or system of operations required, familiar with the use of one or two definite machines or processes, and having, if possible, a certain mechanical instinct and adaptability, the latter to be developed as far as the time at the disposal of the training school will permit. It is inadvisable to attempt to produce the last faculty first, as experience has clearly shown that it is only by starting with the actual job itself and trying to associate with it some degree of wider acquaintance that quick training can be accomplished.

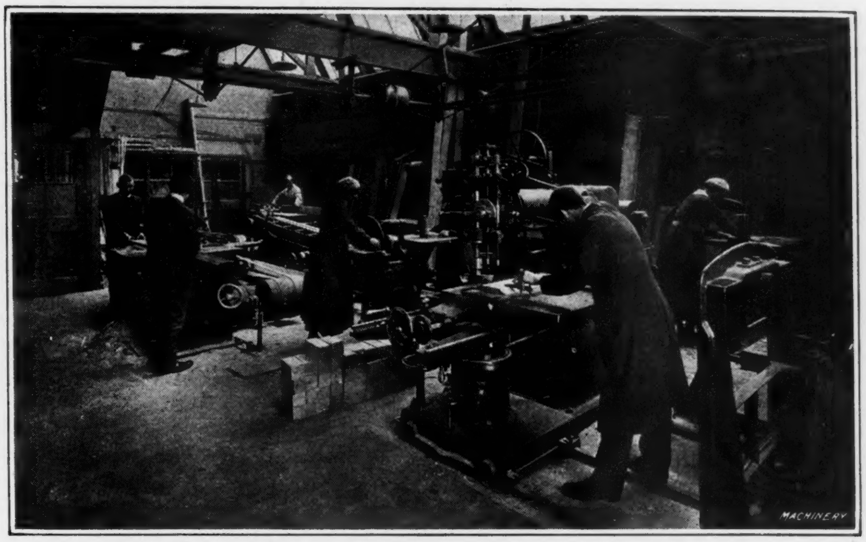


Fig. 1. Corner of Saw Mill in Aircraft Department of Instructional Factory

The Loughborough College

The instructional factory attached to the Loughborough Technical College is an attempt to combine the salient features of the two systems of training at present in vogue in the United Kingdom. The factory runs as one of the departments of the Technical College, and it is essentially controlled by the original staff of that institution. The principal of the college acts as general manager, with the cooperation of a works manager and works superintendent. All three are men who have had a wide practical engineering experience, coupled with university and scientific training. In addition to this, the principal has had the benefit of many years' experience of educational administration, as well as the control of outside productive engineering works. The Loughborough factory thus has the advantage, from the start, of having the educational influence paramount, while, at the same time, the staff is such that actual engineering contract work can be accepted, and the works can be run essentially upon productive lines.

The works now give occupation to some five hundred trainees. They are entirely self-supporting from the engineering standpoint; that is to say, a contract can be accepted in its entirety from the estimating department, through to the drawing-room, the pattern shop, the foundry, and thence through the various machine shops, the automatic shop, the grinding department, on to the inspection department, where the finished article is handled and tested by the factory's inspection staff before being submitted to the government inspector. The gage department is in a position to supply all the necessary gages for dealing with the jobs in the different shops; the heat-treatment laboratory can deal with any parts which require its attention; while the auxiliary departments, such as the blacksmith shop, oxy-acetylene and electrical welding, sheet metal and electrical fitting, can be used as occasion demands.

The above synopsis will show broadly the extent of the factory, but, of course, many of the larger departments are subdivided. Thus, the woodwork section is in a position to deal with airplane contracts, from the smallest component to complete wings and fusilages. It can also train workers upon patternmaking, manufacture of office furniture, and general carpentry and joinery work. All parts of airplane engine production are accepted, from small engine components to actual assembling and testing of the finished engine. In the airplane engine laboratory, in addition to providing facilities for the testing of standard types of airplane engines, considerable attention is now being paid to research work, chiefly concerned with the development of the optical indicator. In every one of the different departments of the factory, trainees are employed upon all branches of work, so that, with the exception of mere heads of departments and responsible instructors, trainees can be supplied from every section from airplane engine testers and airplane erectors down to oxy-acetylene welders and mere machine operators.

Training Adapted to Meet Requirements of Employers

The accompanying illustrations will give some idea as to the extent of the sections of the various departments, and at

Fig. 2. Girl operating Potter & Johnston No. 6A Machine

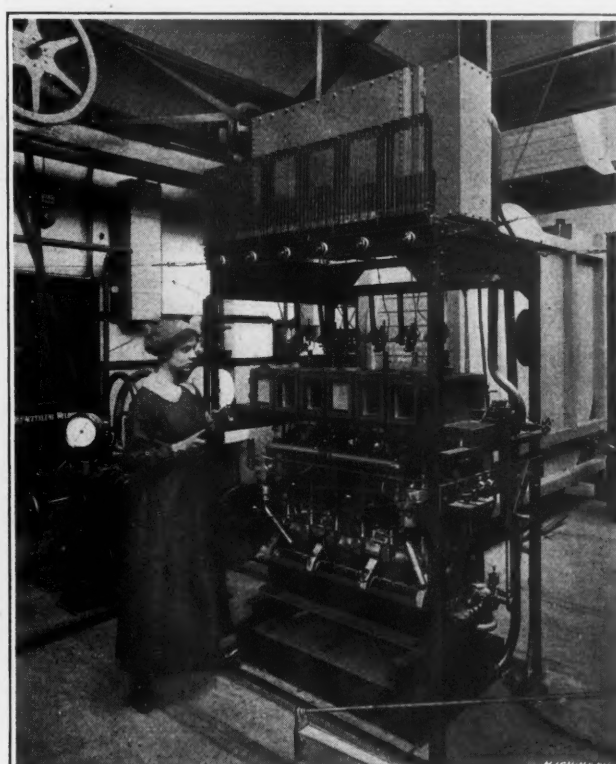


Fig. 3. Woman Tester operating Six-cylinder Airplane Engine

this point it should be emphasized that if sufficient trouble is taken, it is possible to run all sections of such a factory entirely upon an instructional basis. This even extends to the works tool-room, where at the present time, out of some twenty employes, only two are regarded as fully skilled and not available for sending out for dilution purposes. The methods employed, of course, depend largely upon the type of labor required and the applicant for training. As far as possible it is preferred that a firm should state definitely its requirements, and then particular trainees are enrolled to meet these requirements. That is not always possible, and a certain number of trainees have to be taken in without any definite idea as to where they are to be placed or upon what kind of work. It is obvious that if the training can be given under the former conditions, it can be made as specific and concise as possible, whereas if a trainee has to be taken in upon general lines, it is likely that the training will occupy a longer period.

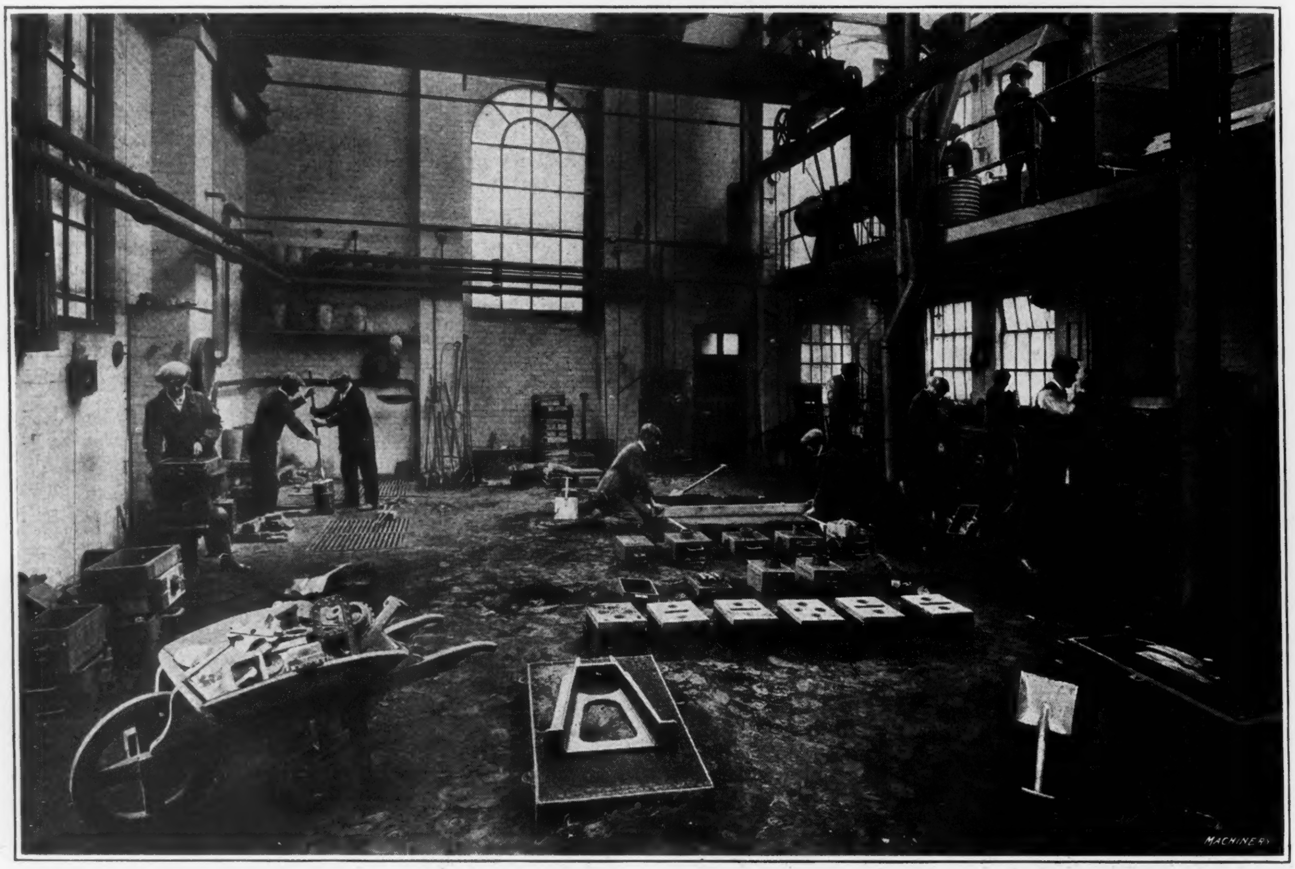


Fig. 4. View showing Trainees working in Foundry

Take one or two cases representing different sections of the works; suppose, for instance, that a firm requires rib-makers for the Avro airplane. These are taken in and placed upon rib-making for that type of airplane, actually producing ribs which are used upon productive work, and in these cases, with an intensive course of some six weeks, it is possible to train a girl who will do rib-making as quickly as anyone with years of general experience. Another firm may require capstan operators to work on, say, a Herbert No. 4 lathe. If it is possible for the instructional factory to accept a subcontract on this particular job, that contract is obtained, girls are put to work upon it, and the process is then one of some four or five weeks' duration in order to impart the necessary mechanical dexterity and aptitude. In such a case as this, the instructional factory would first inquire whether the operator would be required to set or grind her own tools. If she were, instruction in this would be given; if not, no time would be wasted on it.

Length of Time for Training

It cannot be too strongly emphasized that while it would be well to teach certain operations, in general, such labor would be wasted if the operator were not required to perform these operations in the works to which she was sent. The same remark applies to the use of the micrometer. If the firm in question works to limit gages, the operator would not be given any instruction in the use of the micrometer, as such instruction under the circumstances would be merely a waste of time. Another firm may require junior draftswomen. In such a case the training would necessarily extend over a longer period, and it might be advisable to give a certain amount of actual training in one of the machine shops in order to let the trainee have some experience with the engineering faculty. This method particularly applies in the case of trainees who are to take posts as forewomen. Such trainees would be given an omnibus type of training, with, say, one month in each of the several departments, and their training might last from nine to twelve months.

The same is true of women supervisors, and particularly inspectors. It has been found that a much better inspector is produced if he or she has had three or four months preliminary training actually upon the machines producing similar parts to those to be inspected, because in this way a better appreciation is gained of what definite limits really mean. For some time it has been made a rule in the factory that raw trainees were not to be placed in the inspection department, and in all cases transfers were made from other departments of the works. In the case of airplane engine testers it has been found essential to give recruits first of all some idea of mechanical fitting and assembling. The mere method of testing an airplane engine can be acquired by any reasonably intelligent person in a couple of days, but to make an efficient tester, it is necessary that the trainee have some understanding of what work he is really trying to make the engine perform.

Work for which Women are Adapted

It will thus be seen that it is almost impossible to give any general idea as to the length of time spent in a course of training. It necessarily varies, as already stated, and depends upon the type of operator and the work required; it may extend over a period of four to six weeks, or, on the

other hand, to train a really good gage-maker, it may extend over fifteen months. With regard to the experience obtained at the factory in training for this work, one of the most astonishing successes has been the dexterity and ability shown by women in the various processes required for gage-making. A little consideration will show that the great patience required to make gages to within 0.0001 inch is essentially the sort of thing for which women, with their love of fine needlework, would easily become accustomed. It was exceedingly difficult in the early days to persuade engineers that this was possible, and in many cases it was only after they had themselves had an opportunity of seeing the work in progress, that they became convinced and willing to give the girls a trial on such work. Now, of course, it has been abundantly proved that girls make most excellent gage-makers, and we have not the slightest difficulty in placing as many trainees of this kind as we can produce.

Machine operating did not present such serious difficulty, as in the Birmingham area, particularly, it has been the custom to employ women upon automatic machines for such processes as screw making and others of similar nature. The same difficulty was encountered, however, on the question of airplane woodworkers, and at the present time we are attempting to convince the firms concerned that it is quite possible for women to undertake entirely the assembling of wing components.

Selective Training

One definite advantage found in the comprehensive character of the factory organization is the fact that if the initial occupation into which a trainee is placed is not altogether suitable, it is often possible, by a transfer from one department to another, to find a sphere of work in which much better service can be given. Thus, a trainee may come in to the factory desirous of taking up center lathe turning. She may, after a fortnight's trial, be found to be quite unsuitable for this type of work, yet, upon transfer, she may do quite well at such work as sheet-metal components for aircraft. Or again, a girl may find conditions in the actual engineering shops unsuitable for her general health, whereas she would make a success in some department such as the drawing-room or inspection room.

The general experience of those in charge of the factory has led them to the conclusion that in almost all branches of engineering work, it is possible, by a careful system of training along selected lines, to produce operators who can do their particular work as well as a mechanic who has given many years to his training. There are, however, shops which undertake specialized work of an entirely non-uniform character, for which it is exceedingly difficult to train workers satisfactorily. Here, of course, is a case where what is required is experience, and that cannot be given in an intensive course numbered only by weeks; but apart from this class of shop, in all other directions the instructional factory system of training has produced operators who are giving entire satisfaction, and who have, in many cases, even exceeded the output of the more highly skilled operator, paradoxical though this may seem at first sight.

The organization of the works is in all senses parallel with that of an ordinary engineering firm in so far as costing and quoting, as well as engaging, and if necessary rejecting, labor are concerned. Before a trainee can be fully enrolled and given a maintenance allowance, he must satisfy the medical officer attached to the factory that he is physically capable of undertaking the type of work suggested. This means in most cases a fairly thorough medical examination, and often a candidate is rejected at this stage. He is then given a week's further probationary period, during which he is closely watched by the superintendent of the department in which he is placed, and if at the end of that time the superintendent is not satisfied with the application to work, or the ability to learn, he is either rejected or given a trial in some other department.

Fig. 5. Trainees at Work in Drawing-room

Maintenance Allowance

At this stage, a maintenance allowance is given, commencing at the rate of 7½ pence per hour in the case of men, and 4½ pence per hour in the case of women, rising in the two cases to a maximum of 2 pounds and 25 shillings, respectively, or 9 pence per hour for men, and 5¾ pence per hour for women, covering a working week of 52½ hours. The increase from the beginning rate to the maximum is then a matter of recommendation by the shop superintendent to the works superintendent. These increases of payment are

most carefully checked, and only given when the management is convinced that the trainees are really endeavoring to make satisfactory progress. The allowance is regarded strictly in the light of maintenance, and not as wages, yet apart from the fact that it can never reach the standard union rate for the district, it is treated upon a time basis.

Fines Imposed for Breaches of Regulations

Fines are deducted for breaches of regulations, such as smoking in parts of the works or habitual lateness. All trainees are required to punch a time-clock at 7:30, 1:30, and again at 6 P. M. The usual deductions are made if a trainee is later than two minutes, and should this occur on several successive mornings, attention is sharply drawn to the fact. If it should occur again, a fine is deducted and the trainee told that dismissal will follow unless a marked improvement takes place. In this way factory conditions are reproduced as far as possible, and the trainee made to feel that he or she is employed upon serious work, and not merely having a leisurely scholastic course. Up to the present time it has not been found advisable to adopt a piece-work bonus system, although, in the opinion of the author, there are many advantages which would accrue from such a trial. It is argued that payment on piece-work would reduce the efficiency of the teaching, but, on the other hand, it would certainly have a stimulating effect upon the trainees' desire to learn quickly.

Fig. 6. Corner of Surgery, showing Provision made for Treatment of Injuries

Fig. 7. Works Club Room for Trainees, which is maintained as Part of the Welfare Work

Discharged and Disabled Soldiers

At the present time the men recruits are practically all discharged and disabled soldiers. In England there is now little difficulty for any discharged man, who before joining the colors occupied a responsible position, to go back to that position, but in some cases, by reason of the man's physical disabilities, it is impossible for him to do so. In such cases, the instructional factory offers the possibility of retraining and placing in a new walk of life, with the ability to earn a living wage in another capacity. Our experience in this direction so far has been of a mixed character, and could scarcely adequately be dealt with in a short article. There are many reasons why the type of candidate now coming forward is not in the main suitable for training in practical engineering, chief among which is, as already stated, that a man in a good class of work before the war has little difficulty in obtaining similar employment upon his discharge.

Welfare Work

The aggregation of some four or five hundred trainees gathered from a large area into one town necessarily calls for considerable social and moral welfare work. In this respect the instructional factory has developed a special branch. Three hotels are maintained at present, two for women and one for men, and a social club has been erected and equipped in conjunction with the factory buildings, where it adjoins the canteen. The latter provides daily from one hundred and fifty to two hundred dinners, and is used for afternoon tea, which is given to all trainees during a twenty minutes' break in the course of each afternoon. The club room, containing a billiard table and a piano, is open each evening until 9:30, and the proximity of the canteen makes it possible for refreshments to be obtained throughout the evening. A rest room is provided in the works, and this is open each night as a writing and reading room. A surgery is also equipped with modern appliances for dealing with all but the most serious cases. As might be expected, the number of minor accidents is fairly large, since many of the trainees have not previously had experience with engineering tools. By prompt daily attention, however, by a competent woman supervisor and staff, the resultant injuries are made very small.

Each trainee automatically upon enrollment in the factory becomes a member of the social union. A deduction of 2 pence per week is made from the maintenance allowance. This provides the working funds of the union, and enables the committee to purchase representative newspapers and periodicals, as well as to maintain a billiard marker in charge of the table. The social union is controlled by an executive committee jointly representing the management of the factory and the trainees themselves; and from this committee are formed subcommittees which deal with the various activities of the union, such as the house committee controlling the club rooms, and the sports committee directing the athletic side of the union. Abundant facilities for sport are provided in the grounds attached to one of the hotels, where tennis, croquet, and bowls form a common source of amusement. The hotels themselves can be run upon a very satisfactory basis at an inclusive charge of 1 pound per week in the case of women, and 25 shillings in the case of men, and the canteen is now self-supporting.

Placing of Trainees

While every effort is made to make the stay of the trainee at the factory as pleasant and instructive as possible, the relatively low rate of maintenance allowance makes it imperative that all trainees should have ever before them the necessity of securing suitable employment at the earliest possible date. The management of the factory practically guarantees that every trainee shall be found a suitable job before he is discharged, and up to the present there has been no difficulty in keeping such a promise. On the whole, the secret of success is contained in what might be regarded as "repeat orders," and at present the demands for trained labor from the instructional factory exceeds the supply.

MACHINING BASE PLUG FOR 9.2-INCH HIGH-EXPLOSIVE HOWITZER SHELLS

SUCCESSIVE ORDER OF OPERATIONS AND MACHINES, TOOLS, AND GAGES USED

BY M. H. POTTER[1]

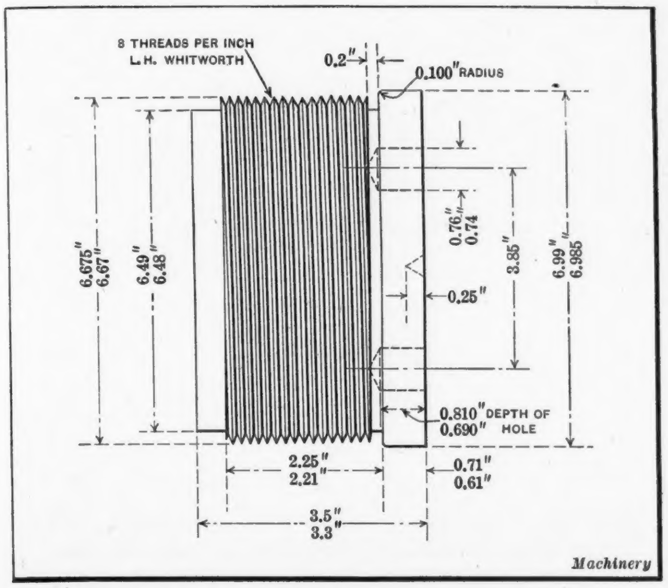


Fig. 1. Base Plug for 9.2-inch High-explosive Howitzer Shell

THE base ends of small shells are forged solid, but some of the larger sizes (such as the 9.2-inch high-explosive howitzer shell) are forged with the base ends open, and these ends are afterward closed by screwing in adapters or base plugs. The solid end, or the one that is integral with the shell forging, is desirable, but the increased expense of forging and machining large shells having closed ends is one reason why the open-end forgings are used in preference. One of the important features connected with the manufacture of these large shells is machining and assembling the base plug which must fit tightly into the base and hermetically seal it. If the shell base were not absolutely tight, the propelling charge might cause the charge in the shell itself to explode at the instant of firing. In the September number of MACHINERY, the successive operations and gaging equipment for producing 9.2-inch howitzer shells were described, and in this article the work on the base plug is explained. This plug is illustrated in Fig. 1, which shows the limits or tolerances allowed.

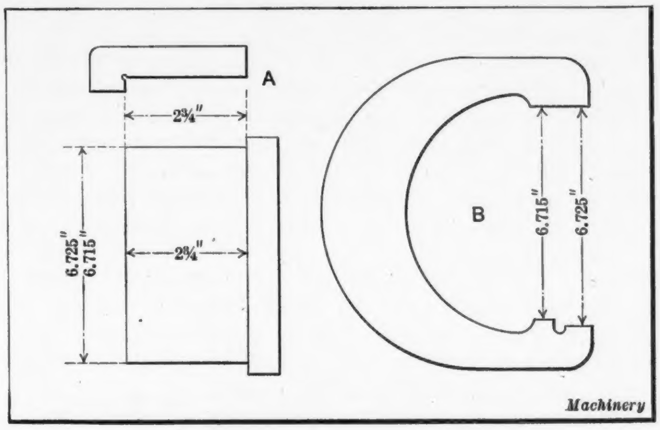


Fig. 2. (A) Gage for Length of Body. (B) Limit Snap Gage for Body Diameter

First Operation—Rough-turning and Facing Body

Three Lodge & Shipley 24-inch engine lathes are used for this operation, and the base plug is held by its flange in a three-jaw universal chuck. Gage *A*, Fig. 2, is for the length of the body, and the limit snap gage *B* for the body diameter.

Second Operation—Rough-turning Face and Flange

Four Lodge & Shipley 24-inch engine lathes are used, and the base plug is held by its body in a three-jaw universal chuck. Gage *A*, Fig. 3, is for the width of the flange, and the limit snap gage *B* is for the flange diameter.

Third Operation—Drilling Two Holes

The base plug is held in a box jig with its flange upward, and the holes are drilled with a 35/64-inch drill in a Champion drilling machine. These holes are subsequently used for screwing the base plug into the shell base. The plug after the third operation is shown at *A*, Fig. 4. The working gage for the maximum and minimum depth of the drilled holes is shown at *B*.

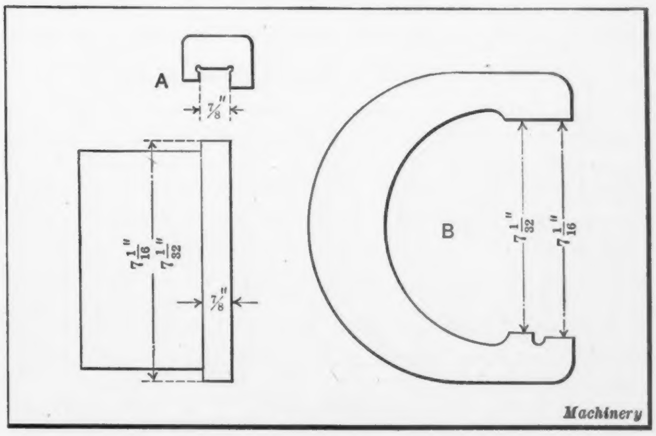


Fig. 3. (A) Gage for Width of Flange. (B) Limit Snap Gage for Flange Diameter

Fourth Operation—Tapping Two Holes

The base plug is held with its flange upward in a special vise, and a 5/8-inch U. S. standard tap is used. The machine is a Barnes drilling machine, and the tap is held in an Errington automatic reversing attachment.

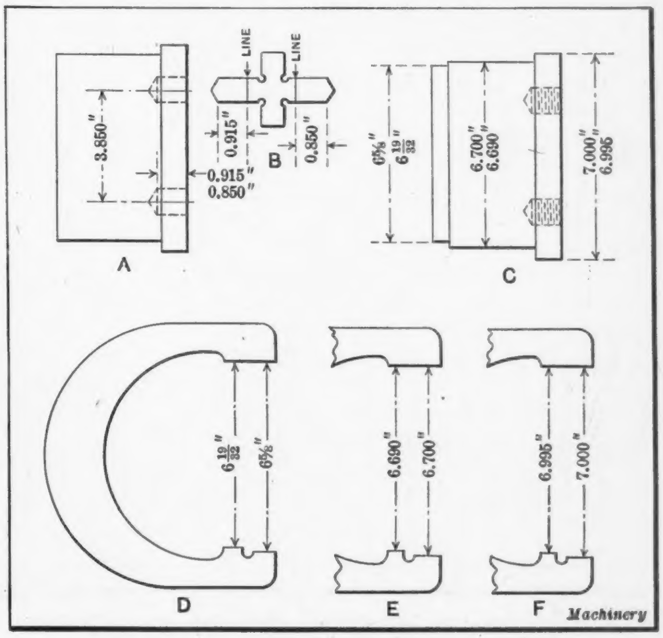


Fig. 4. Base Plug after Third and Fifth Operations, and Gages used

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Fifth Operation—Rough-turning Flange, Body, and Pilot

The base plug is held by the two tapped holes in its flange on a special faceplate, and four Fairbanks 20-inch engine lathes are used. Working gages are shown at *D*, *E*, and *F*, in Fig. 4. Gage *D* is for the flange, gage *E* for the body, and gage *F* for the pilot. The plug after the fifth operation is shown at *C*.

Sixth Operation—Milling Thread

Holden-Morgan thread milling machines are used for this operation, and the base plug is held by the two tapped holes in its flange. The machines are of the multiple-cutter type and complete the thread in practically one revolution of the work. A 7-inch micrometer is used for testing the size. The plug after the sixth operation is shown at *A*, Fig. 5.

Seventh Operation—Redrilling Wrench Holes

The threads in the tapped holes are next removed by enlarging the holes with a 3/4-inch drill. These holes were tapped previously for holding the plug, as mentioned in connection with the preceding operations. The plugs are held with the flange upward in a box jig, and two Reed-Prentice drilling machines are used. No gages are required. The plug after the seventh operation is shown at *B*, Fig. 5.

Eighth Operation—Finish-turning Recess

The recess next to the flange is turned in a Lodge & Shipley 24-inch engine lathe, and the base plug is held by its body in a three-jaw universal chuck. The jaws are threaded to match the threads on the plug body. This recess is shown at *C*, Fig. 5, and gage *D* is used for testing the width and depth.

Ninth Operation—Finish-turning Pilot and Flange

A 24-inch Lodge & Shipley engine lathe is used, and the base plug is held by its body in a three-jaw universal chuck, the jaws being threaded to match the plug thread. The plug after the ninth operation is illustrated at *E*, Fig. 5. The working gages are shown at *F* and *G*. Limit gage *F* is for the flange diameter, and gage *G* for the diameter of the pilot.

Tenth Operation—Finish-facing Pilot to Length

The base plug is held by its flange in a three-jaw universal chuck. Two 24-inch Lodge & Shipley engine lathes are used. The working gage *A*, Fig. 6, is for the length of the pilot, the plug being finished as shown at *B*.

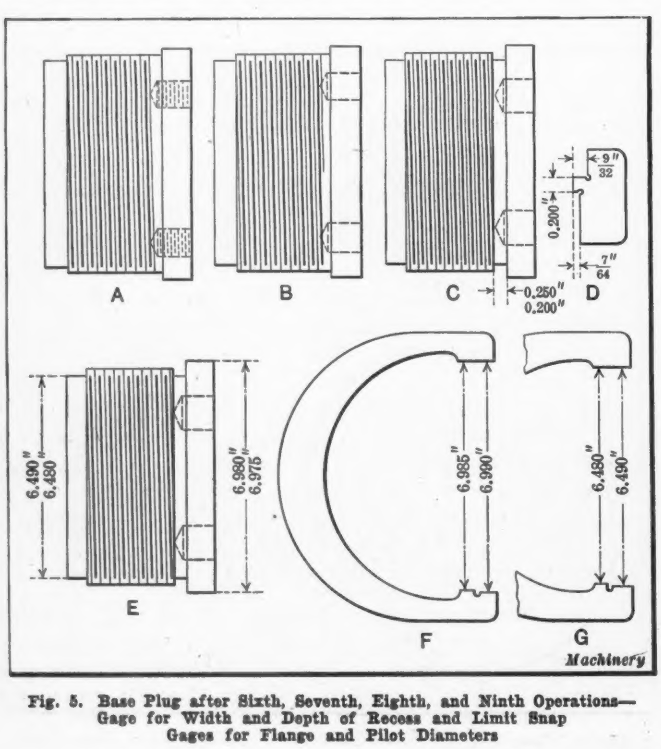

Fig. 5. Base Plug after Sixth, Seventh, Eighth, and Ninth Operations—Gage for Width and Depth of Recess and Limit Snap Gages for Flange and Pilot Diameters

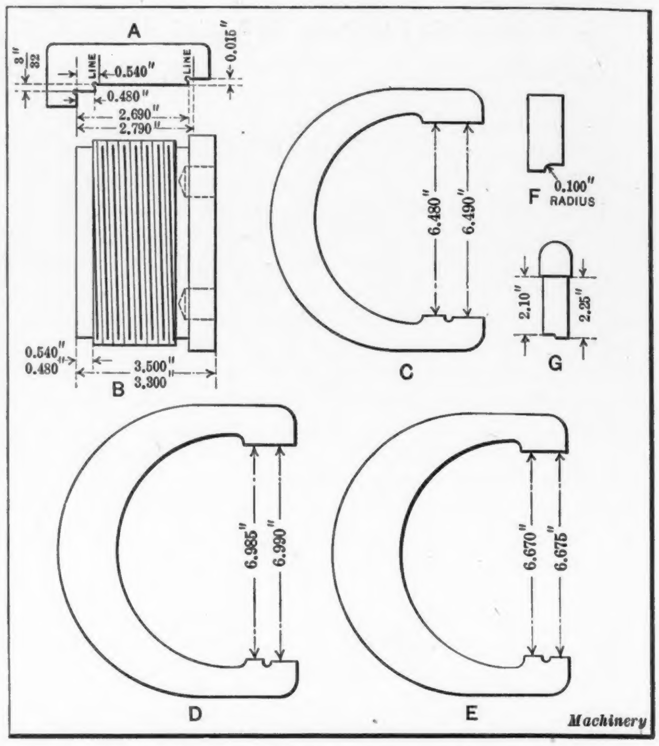

Fig. 6. Base Plug after Tenth Operation and Inspection Gages

Eleventh Operation—Burring Threads and Inspecting

After the removal of any burrs that may have formed, the plugs are inspected by using the following gages: Limit snap gage *C*, Fig. 6, for the diameter of the pilot; limit snap gage *D* for the diameter of the flange; limit snap gage *E* for the diameter of the body; gage *G* for the length of the thread; and gage *F* for the radius of the flange.

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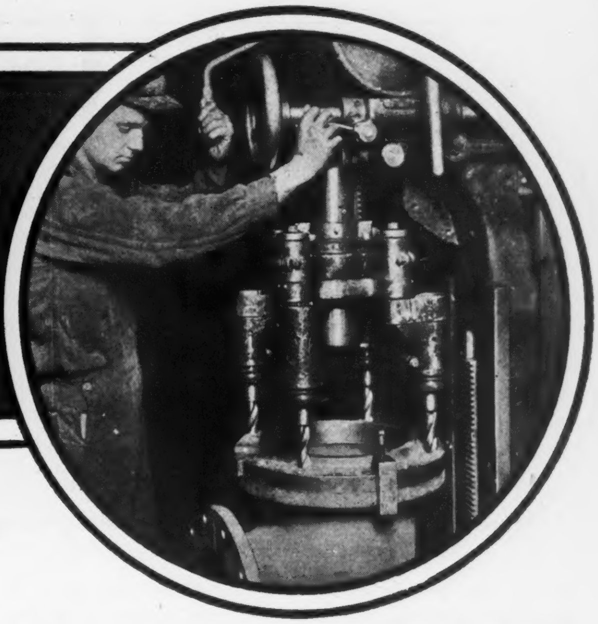
PENSION SYSTEM OF A LARGE MANUFACTURING PLANT

Some interesting facts in regard to the continuity of service of the employes of the General Electric Co. at Schenectady, N. Y., are given in an article by Charles M. Ripley appearing in a recent number of the *General Electric Review*. The records show that half of the total number of men at this plant have been steadily employed five years or longer. One out of every five has been employed ten years or longer, and one out of every thirty-four has been employed steadily twenty-five years or longer. Thus the 660 members of the Schenectady Quarter Century Club have served a total of 19,000 years; that is, their total years of service if represented by the life of one man, would amount to 19,000 years. Out of a total of 17,099 employes, twenty-six have served thirty-three years; fourteen, thirty-five years; and one, thirty-nine years.

The pension system of this company provides that all workers who have had twenty-five years' continuous service may be retired with a pension which continues until death. According to a strict interpretation of the pension rules, men must be retired at the age of seventy, and women at the age of sixty, unless special arrangements have been made with the pension board. The pension is based upon the average annual wages for ten years prior to retirement, and also the total number of years of continuous service.

The exact method of figuring the pension is as follows: The average annual wages for ten years prior to retirement, multiplied by the number of years in service, multiplied by 1½ per cent. For example, for one whose service has been continuous for thirty years and whose average earnings for the last ten years have been $2500 per annum, the annual pension upon retirement would be $1125. Such an employe, retiring at the age of seventy and living to the age of eighty, would receive a total sum in pensions of $11,250 according to the schedule in force at the present time.



Multiple-Spindle Drilling Heads

Advantages and Construction of Various Types

BY F. SERVER

THE advantages of multiple-spindle drilling machines are obvious when large quantities of similar work must be done, but there is also much work that can be done by means of multiple-spindle drill heads attached to the ordinary drilling machine. These heads may have fixed centers, thus being suitable for one particular job of which a large quantity is to be made, or they may be made adjustable for general jobbing purposes within the range or center adjustment of the tool. In some cases it is profitable to make a special drill head and a jig to be used together; then the two tools are always ready for use and the same job may be performed economically at intervals as required. The use of a multiple-spindle drilling head reduces the time necessary for drilling inversely as the number of spindles is increased. All of these heads may be used on either the radial or plain type of drilling machine, and where made of small capacity they are sometimes used for sensitive drilling; it might be well to note that heads for sensitive drilling machines are quite often rugged enough when made with aluminum bodies.

One type of drill head that is in quite general use is shown in Fig. 1; it is most useful for general utility purposes. This head is attached to the drilling machine by means of a sleeve *A* and drives four drills *B* through spur gears which are enclosed in the case *C*. These spindles are adjustable as regards center distance. The method of adjusting them is shown in Fig. 3. These heads are frequently referred to as auxiliary heads, inasmuch as they can be used for general jobbing purposes and need not be made with the idea of applying them to any particular job.

Drill Speeder

Closely allied with these multiple-spindle heads is a drilling tool known as a "drill speeder." In general appearance it is not unlike a multiple-spindle drill head, but instead of drilling more than one hole, it is simply made to accommodate one small drill. When this tool is attached to an ordinary drilling machine, the small drill is given two or three times the speed of the drilling machine spindle. It is held in the drilling machine spindle in the usual manner by means of the driving shank, and a lever that comes into contact with the uprights on the machine prevents the case from turning. This tool is especially useful when drilling large work containing small holes, as by this means correct drilling speeds for small drills can be obtained on a large machine; or, after drilling a large hole, a small hole may be drilled by simply changing from a large drill to this tool. Incidentally, considerable wear and tear on the machine through high speeds is avoided.

Straight-line Drill Heads

A type of drill head that may be used for drilling a number of holes in a straight line is shown in Fig. 2. The head

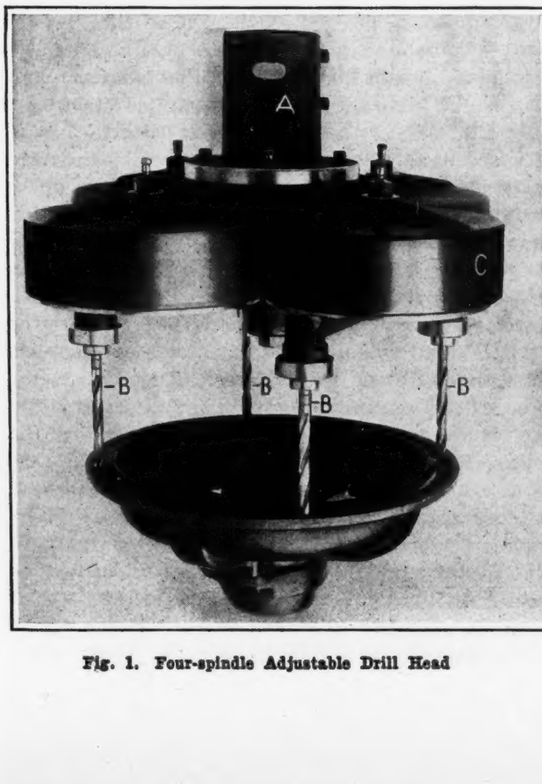


Fig. 1. Four-spindle Adjustable Drill Head

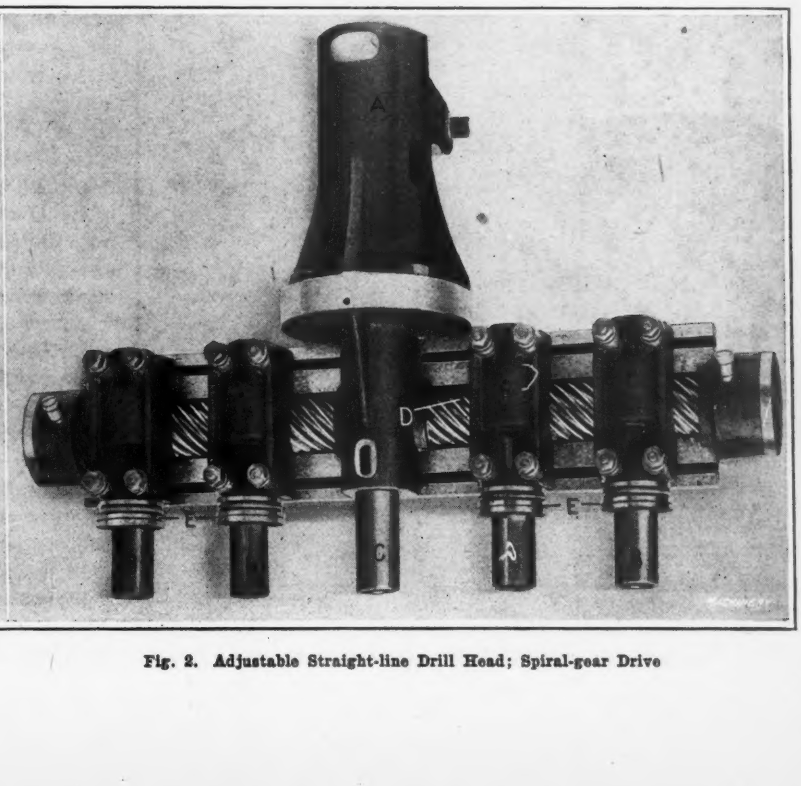


Fig. 2. Adjustable Straight-line Drill Head; Spiral-gear Drive

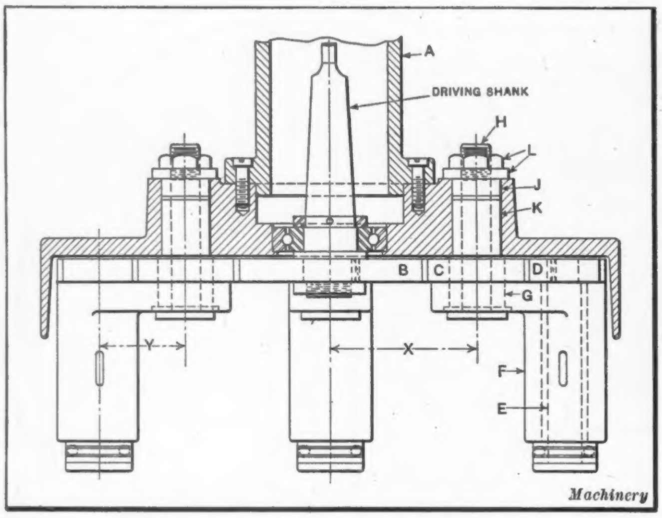


Fig. 3. Construction of Drill Head shown in Fig. 1

shown has five spindles. The four spindles *B* are similar in construction, while the one at *C* is slightly different. This drill head has an adapter sleeve *A* for attaching to the quill of the drilling machine. In operation, the spindle of the drill press drives the center spindle of the head, which is provided with a spiral gear that is not visible in the illustration. This spiral gear drives the long spiral gear *D* that, in turn, drives gears on the auxiliary spindles on each side of the center spindle. Ball bearings *E* on the four auxiliary spindles *B* take the thrust of the drill. The auxiliary spindles *B* are adjustable as regards center distance, so that any number of spindles in a straight line, within the capacity of the tool, may be used, for the spiral gear drive is not dependent on fixed centers, as are some other types of gear-driven, straight-line heads.

A straight-line, multiple-spindle drill head that has ten spindles and a spur gear drive is illustrated in Fig. 4. The gear arrangement is somewhat elaborate, but this is a very efficient head. Like the preceding drill head, it is attached

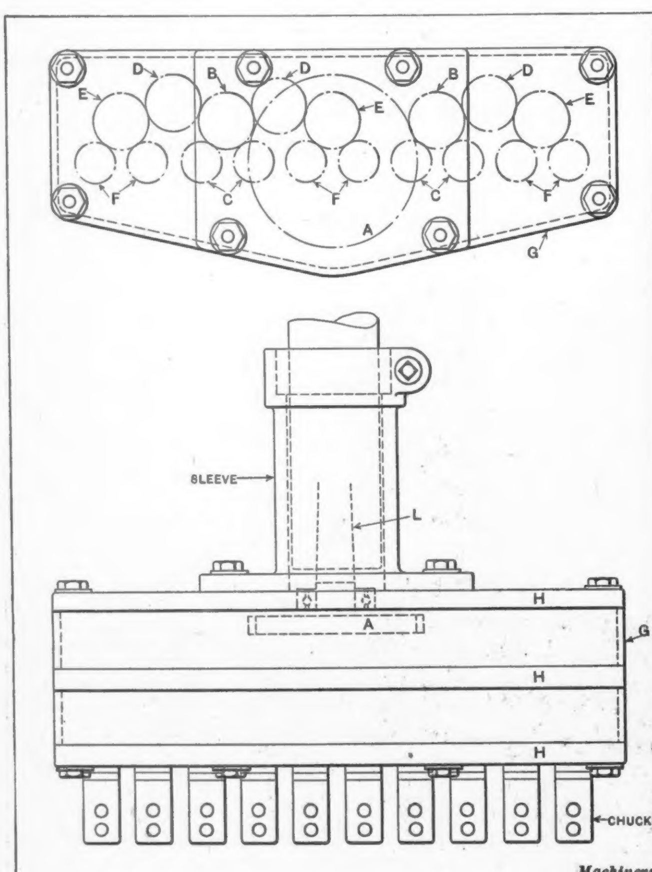


Fig. 4. Ten-spindle, Straight-line, Gear-driven Drill Head

to the quill of the machine by means of a sleeve. The taper shank *L* fits into the spindle of the machine in the usual manner, and thus drives the center gear *A* which, in turn, drives two idler gears *B*. These two gears drive two spindles *C* on each side of the center. They also drive the three gears *D*, which, through gears *E*, drive the six drill spindles *F*. This gearing is enclosed by a case *G*, and bearings are provided for the spindles in the three plates *H*. The drill chucks may be screwed onto the end of the spindles or they may be made solid with them, depending on the size of the gears and the convenience of assembling. Heads on the same general principle can, of course, be made for either a greater or smaller number of drill spindles, care being taken when arranging the gears to have all the spindles revolve in the same direction. This sometimes necessitates the use of extra gears. Unless this care is exercised, right- and left-hand drills will have to be used, with the attendant confusion.

Internal Construction of Straight-line Drill Heads

To illustrate the internal construction, two sectional views of heads of this type are shown in Figs. 5 and 6; the one shown in Fig. 5 is for drill spindles arranged as in Fig. 4, and is known as a three-plate construction. The head shown in Fig. 6 is a two-plate construction that may sometimes be

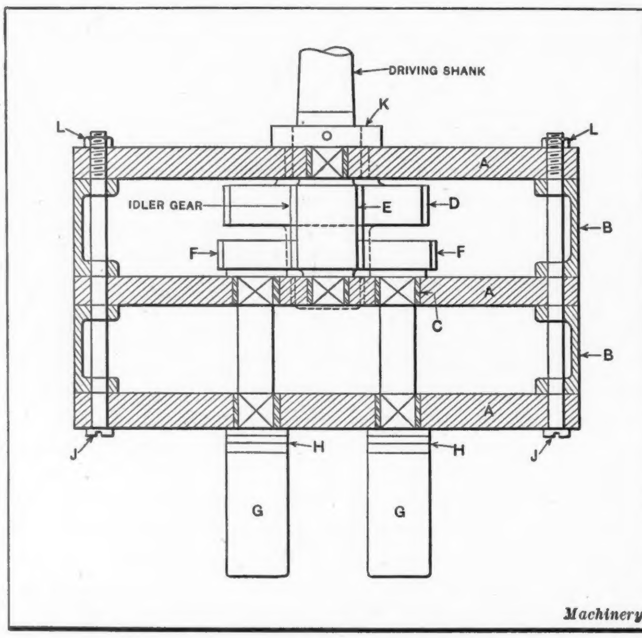


Fig. 5. One Type of Plate Construction and Gear Drive

used to advantage when the center distance of the spindles is not relatively short.

In the three-plate construction shown in Fig. 5, the plates *A* are made of steel or cast iron; they are separated by spacers or supports *B* and carry bronze bushings or ball bearings *C*. The sleeve, which is not shown, by means of which the head is attached to the drilling machine, is bolted to the upper plate *A*, and the driving shank fits the spindle of the drilling machine, having a large gear *D* on the lower end. This drives the idler gear *E*, which, in turn, drives the two spindle gears *F*. The driving shank, with a gear mounted on it, has two bearings, one in the upper and the other in the middle plate; the drill spindles also have two bearings, one in the middle plate and one in the lower. To complete the drill spindle construction, suitable chucks *G* and thrust washers or collars *H* are provided. It is immaterial whether the chucks are screwed in place or are held by screws to the drill spindles; it is also immaterial to the operation of the head whether the chucks are special or whether they are some one of the many commercial drill chucks on the market. To hold the plates *A* and the spacers *B* in place, or, in fact, to hold the entire drill head together, suitable screws *J* and nuts *L* are used. A collar *K* pinned to the driving shank completes the construction. Although only two spindles are

shown in this illustration, a number of spindles may be similarly arranged.

In the construction shown in Fig. 6, it is only necessary to have two plates *A*, on account of the spindles being spaced some distance apart. A bearing for the spindles *B*, the idler gears *C*, and the driving shank may be conveniently obtained in these, as none of the gears overlap and thus prevent the studs or shanks running through the plates. In the three-plate construction, Fig. 5, the spindles *G* cannot extend into the upper plate *A*, as they would then have to pass through the gear *D*, which, of course, could not be done. In the two-plate construction, however, the idler gears *C* and the spindles are at one side of the gear *E* attached to the driving shank.

A drill head containing twelve spindles of fixed center distance, spirally driven in a similar manner to those shown in Fig. 2, is shown in Fig. 10. This head operates in the same manner as that in Fig. 2, the only difference being that the spindles are fixed and the body containing the spindles is, therefore, provided with no adjustment features.

Construction of Auxiliary Drill Heads

The construction of the adjustable drill head shown in Fig. 1 is illustrated in Fig. 3. In this type of head each

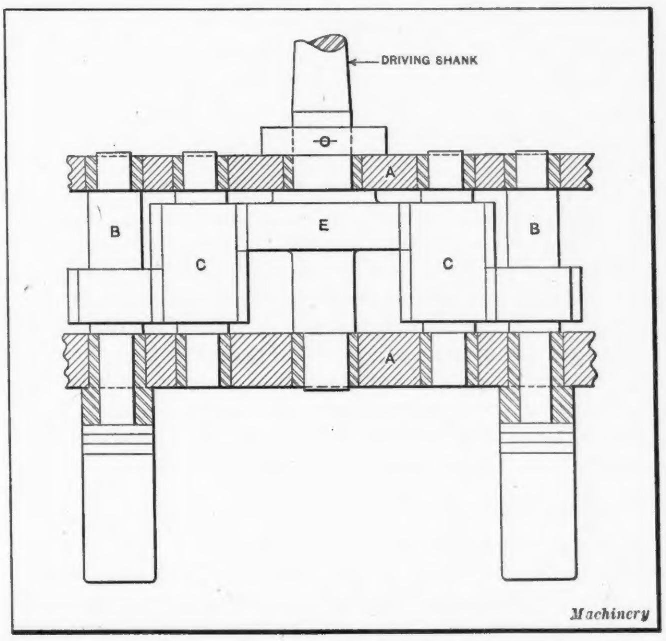


Fig. 6. Another Type of Construction Similar to that shown in Fig. 5

spindle and driving member is a complete unit, and as many of these units or clusters as can be mounted in the head can be used. Each cluster is held to the body of the drill head by a bolt and is adjustable around this bolt as a center. The drill head is attached to the drilling machine by means of the sleeve *A*. The driving shank, which fits into the tapered hole of the machine spindle is shown inside of this sleeve, and a large gear *B* is keyed in place on the end. This large gear meshes with an idler gear *C* that, in turn, meshes with a gear *D* on the upper end of the drill spindle *E*. This spindle *E* is held in a spindle carrier *F*, in which a bushing *G* is placed. Idler gear *C* rotates on this bushing. The pivot stud *H* runs through this bushing and through two bushings *J* and *K*. When assembling, all of these parts are held on one carrier by means of the nut and washer *L*. This complete unit may then be adjusted radially around the center spindle on the radius *X*, and as the drill spindle also revolves on the radius *Y* around the stud *H*, a hole in any position within the range of the tool may be drilled. By having a number of elongated slots in the body of this drill head and a number of auxiliary spindle units, several spindles may be used at one time. The body of these cluster type drill heads is sometimes made in two parts, which are known as outer and inner rings. This eliminates

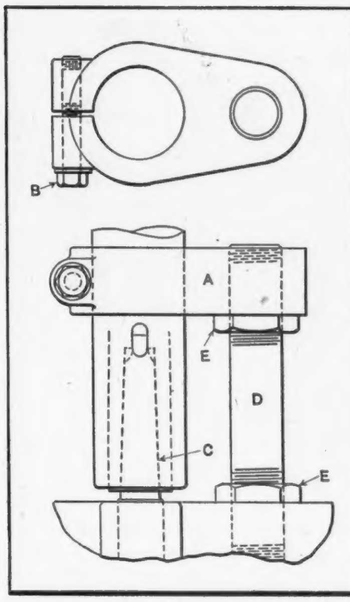


Fig. 7. Method of mounting Spiral-drive, Fixed-center Drill Head

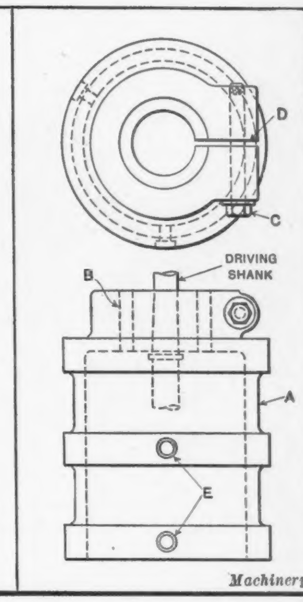


Fig. 8. Method of mounting Drill Head shown in Fig. 13

the elongated slots and makes a slightly more flexible tool as regards the number of auxiliary spindle units that may be placed in the body, as the number of spindles is thereby not dependent upon the number of elongated slots cut in the head. The center spindle can also be made to hold a drill, so that work having a center hole and a number of holes around it may be completely drilled. The two-spindle head shown in Fig. 12 has one fixed and one adjustable center *A*, the latter being held in position by the bolt *B*.

Two-spindle Drill Head with Chucks on End of Spindle

A two-spindle drill head having chucks mounted on the ends of the spindles is shown in Fig. 11. This is adjustable as regards center distance, and the bolts *A* clamp the spindle when it is adjusted to the correct center distance. Thrust ball bearings *B* are used with this head, and the chucks are fitted to the ends of the spindles in the usual manner. This head is held to the quill of the machine by a sleeve.

Fig. 7 shows the principle involved in mounting the head on a spindle quill of the drilling machine. Although this construction differs somewhat from the heads shown in the

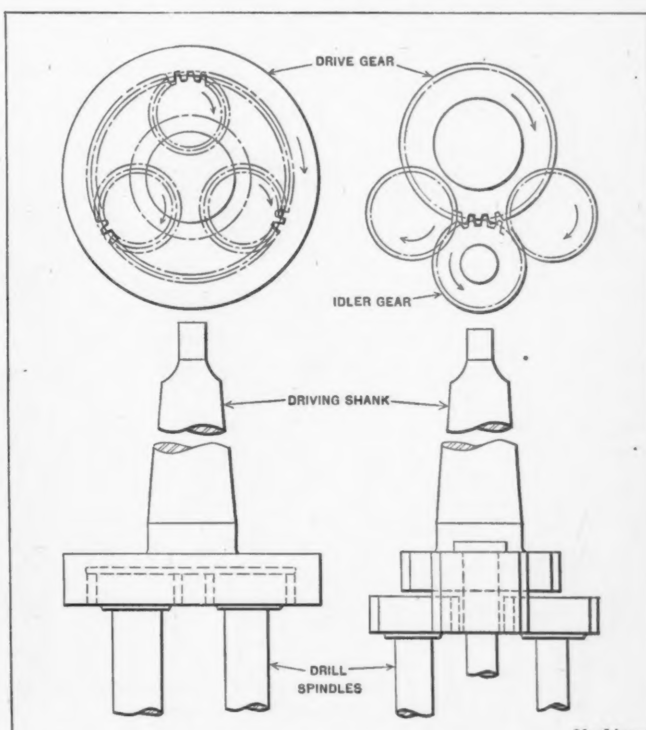


Fig. 9. General Construction of Cluster Type Drill Head

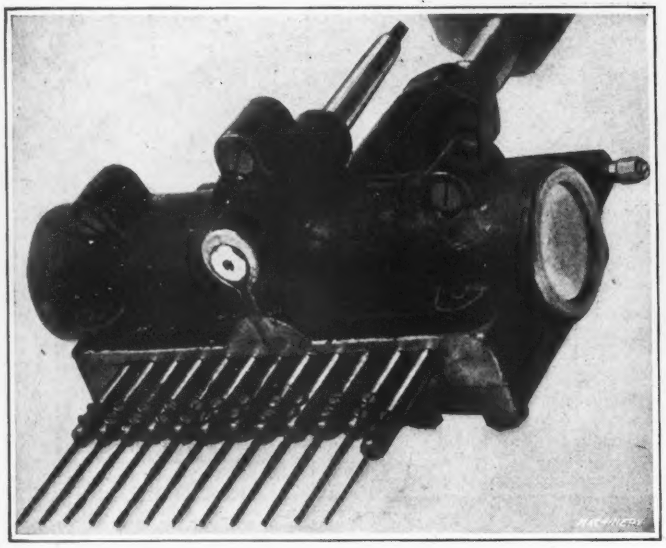


Fig. 10. Twelve-spindle, Fixed-center Drill Head

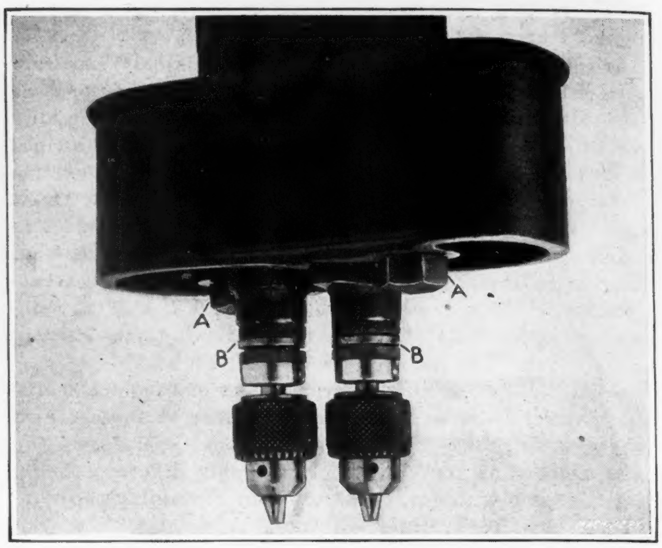


Fig. 11. Two-spindle Drill Head with Chucks

preceding illustrations, inasmuch as the others have cast-iron sleeves that entirely enclose the end of the quill, the principle is the same. The yoke *A* is clamped to the quill of the drilling machine by means of a bolt *B*. The driving shank *C* in the drilling machine spindle drives the gears in the head, thus causing the various drill spindles to revolve. The drill head is held to the yoke *A* by means of the tie-rod *D*, which is locked by the check-nuts *E*. The drill head, therefore, is suspended on the quill of the drilling machine; if the head should be heavy, two or more tie-rods should be used. The completely enclosed models are, of course, somewhat stiffer than these, and look a little more finished.

Combination Drill Spindles

In Fig. 8 is shown a cast-iron sleeve *A* that fits over the combination of drill spindles shown in Fig. 13. This is a typical mounting example of the spur gear type. The bushing *B* is slipped over the quill of the machine; it is sometimes necessary to cut this bushing so that it will clear the rack that feeds the quill. The sleeve is clamped in position by means of a bolt *C*, the sleeve and bushing being split at *D*, so that by binding with the bolt, the head will be clamped on the quill of the machine. The driving shank is part of the drill head illustrated in Fig. 13. This whole combination of drills, there being sixteen, is slipped into the sleeve, Fig. 8, and is held securely by means of dowel pins and screws at *E*. A feature of this type of drill head is that, owing to the various drills being so close together it is necessary to make special chucks which are alternately long and short, as shown in Fig. 13. The long chucks are necked down in diameter to accommodate the large diameters on the short chucks; this is necessary in order to obtain sufficient material in which to place the screws that are used to clamp the drills.

Construction of Fixed-center Drives

In Fig. 9 two types of fixed-center drives are shown to illustrate the internal construction or arrangement of gears. In the left-hand view is shown an internal drive. The internal gear is attached to the driving shank of the drill head or is made part of the driving shank; each is designated in the illustration as the drive gear and rotates in the direction of the arrow. The three drill spindles are shown in mesh with this gear. This type of drive eliminates intermediate gears, as the drill spindles will revolve in the same direction as the spindle of the machine without the provision of intermediate gears.

At the right of Fig. 9, a fixed-center external drive is shown, the driving shank having the drive gear cut on it. This drive gear meshes with an idler gear, which, in turn, meshes with gears on the upper end of two drill spindles. The drive gear turns to the right and the idler gear turns to the left, so the two drill spindles are thereby driven to the right. In this construction quite a little room is required, as the drive gear must be set off to one side, while the internal drive arrangement may be made concentric, so to speak. Also, in the internal-gear drive the gear part of the arrangement is shorter, as it is not necessary to have a double width face idler gear that extends from the large drive gear to the drill spindle gears. Of course, in the external drive, if the drill spindle can be placed clear of the drive gear, it will not be necessary to have this double width face idler gear, but on short center distances, in order to obtain a proportionately large size drive gear, it is usually necessary for the drive gear to overlap the spindles.

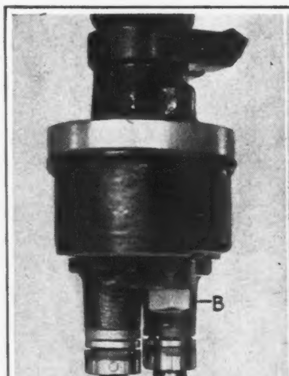


Fig. 12. Two-spindle Head with One Fixed and One Adjustable Spindle

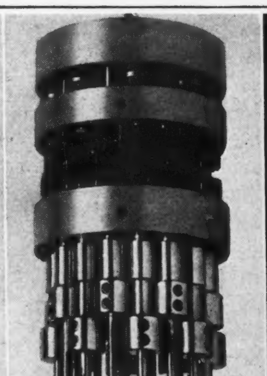


Fig. 13. Sixteen-spindle, Fixed-center, Spur-gear Drive

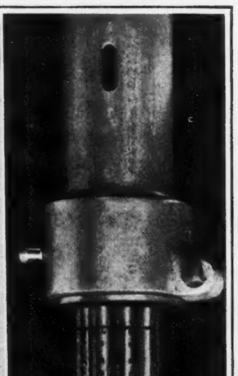


Fig. 14. Close Center Distance Cluster Type Drill Head

Heads with Close Center Distances

As an example of close center distance working, the seven-spindle drill head shown in Fig. 14 is of interest. This is very compact and can be made to be driven by either of the methods shown in Fig. 9. Small drill spindles of this type are often assembled in a disk, which is then forced into the sleeve of the drill head and is clamped in place by means of a binder screw. It is sometimes difficult to decide what means of holding the drills may be used where the cen-

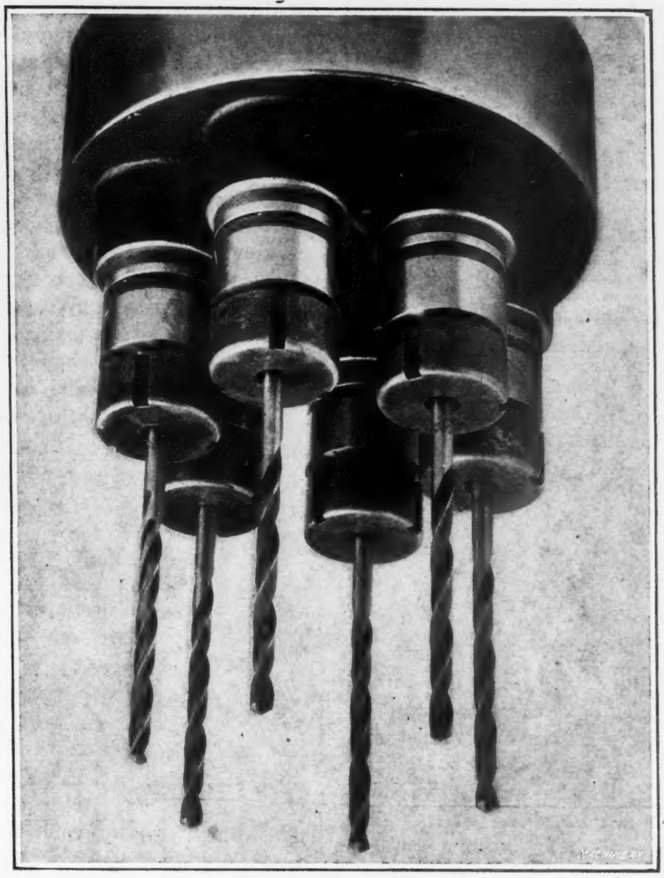


Fig. 15. Six-spindle Head with Special Chucks

ter distances are not very far apart. This is usually a matter of choice, but if the center distances are very short, the type of chucks used must necessarily be such as will run in this center distance. Fig. 15 shows a six-spindle head with six chucks attached to it. These chucks are tightened by means of a spanner wrench and will run in fairly close center distances, depending somewhat upon the size of the drill. This chuck construction is illustrated in the lower view of Fig. 18, and will be seen to be of the spring collet type.

The shank *A* drives into the spindles of the drill head, and in the chuck shank a small split collet *B* is placed. The drill is placed in this collet and the nut *C* is used for forcing the collet back into the shank of the chuck. The collet is split so that the tapering end of the shank causes the collet to bind the drill in the usual manner. One end of the tightening nut *C* is hexagonal in shape, so that a wrench may be used, though, as shown in Fig. 15, nuts with slots for a spanner wrench are also used. This type of chuck is varied as conditions warrant, the collet often being incorporated as part of the shank and not as a separate piece. Where the center distance between holes is very close, the types of chucks shown in the upper part of Fig. 18 are often used. These consist of a round piece bored and tapped to fit on the end of the drill spindle. The body of the chuck is shown at *D*, the drilling spindle at *E*, and the two screws *F* are used for holding the drill. The chuck in the upper left-hand corner is made to screw on the spindle end, while the one to the right is held to the end of the spindle by means of the two screws *G*. When the center distances between holes are extremely close, the drills will be correspondingly small; these are then sometimes placed directly in the spindle and held there by screws. The thrust collar *H* comes against the spindle bearing; ball thrust bearings are sometimes used instead of the collar.

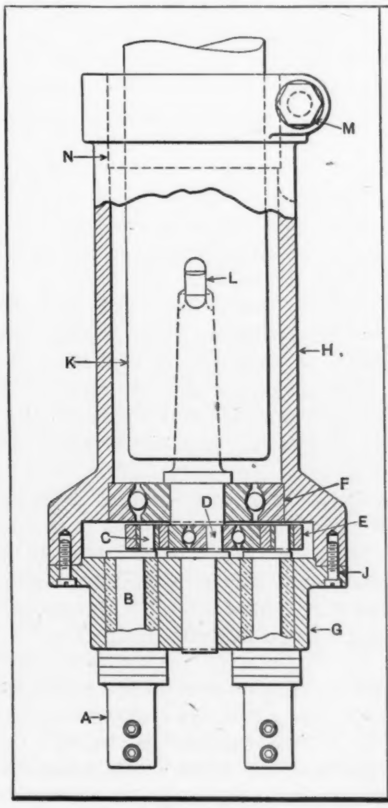


Fig. 16. Eccentric Drive Type of Drill Head

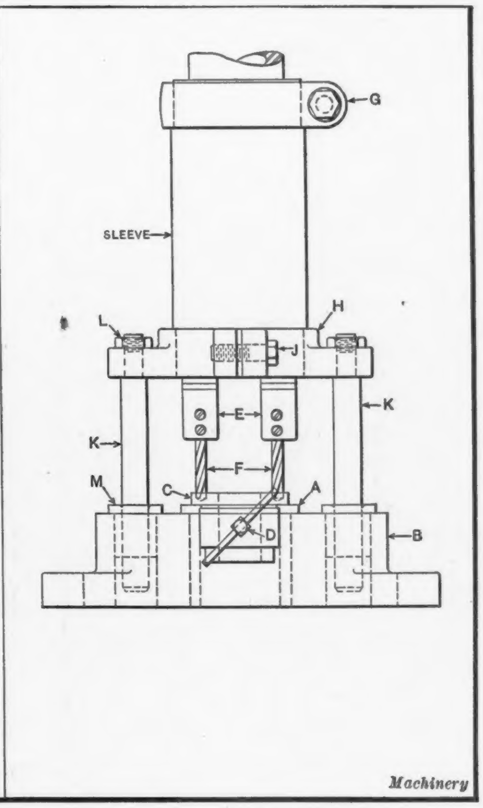


Fig. 17. Drilling Two Spanner Wrench Holes in Nut

Universal Joint Drive

Another type of drive that is sometimes used for adjustable drill heads is the universal joint drive. The construction of this is similar to or may be any of the standard types of universal joint that are on the market. Fig. 19 shows its application in a multiple-spindle auxiliary drill head. The driving shank has a gear *A* that meshes with gear *B* attached to a stud. This stud drives one end *C* of the universal joint; the other end *D* drives the drill spindle to which is attached the chuck or other suitable means for holding the drill. This arrangement shows two spindles, but any number of spindles may be placed in a circle, and if the spindles are carried in adjustable brackets, they may be adjusted to various center distances. The arrangement shown is just a general outline, and it must, of course, be mounted with suitable bearings contained in a body and an adapting sleeve for attachment to the drilling machine.

Eccentric Drive Drill Head

A type of drill head by means of which all gears are eliminated is shown in Fig. 16; this is known as an eccentric drive, and the drill centers are fixed. The chuck *A* screws on the end of the drill spindle *B*, the other end *C* of which is eccentric. The end of the driving shank *L* is also machined eccentric on all of the drill spindles, which are caused to run in the ring and are revolved thereby, thus making the spindles turn. In action, this ring *E* is continually traveling with an eccentric motion, and it is this eccentric motion or wabble plate action that causes the drill spindles to turn. A large ball bearing *F* for the center spindle and bushings or suitable drill spindle bearings complete the wearing parts of this head. For convenience in manufacture, the spindles are mounted in a carrier

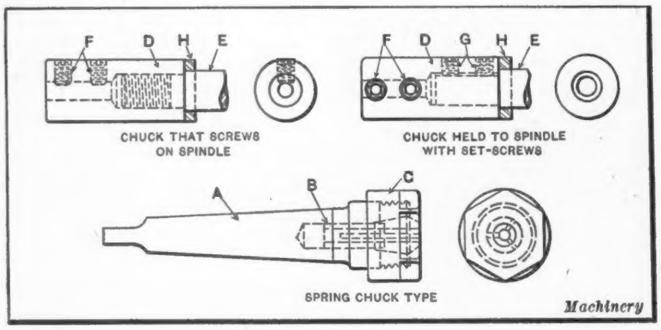


Fig. 18. Special Small Drill Chucks

plate *G* that is held to the sleeve *H* by means of the screws *J*. The adapter sleeve fits over the quill *K* of the machine and is clamped to it by the clamping bolt *M*. A split binding bushing *N* is placed inside the sleeve. Drill heads are often used in connection with a work-holding jig, particularly where a fixed-center type of drill head is made to do one job only. In this case, it is often advisable to manufacture the jig and drill head so that they will work together or be in alignment.

Drilling with Multiple Head and Jig

Fig. 17 shows a plain two-spindle drill head in use with a jig for drilling two holes in a bushing. The jig contains a work-holding bushing *A*, which is carried in a cast-iron base *B*. The work *C* is placed in this bushing and is clamped in place by the screw *D*. The drill head carries two spindles *E*, and thereby two holes are made by the drills *F*. This drill head is clamped to the quill of the machine in a suitable manner, in this particular instance by a clamping ring *G*. On the end of the drill head a bracket *H* is held in position by the binder bolt *J*. Two guide posts *K* are driven into this bracket and are securely held in place by nuts *L*; these guide posts enter the bushings *M* in the jig, so that the drill head, as it slides up and down, is held in line with the jig. The arrangement of the guide rods should be varied to suit the particular job in hand; this point will be exemplified by the three views shown in Fig. 20.

Piloted Drill Heads

In the left-hand view of Fig. 20, the guide rod is placed in the center of the drill head with the drill spindles *A* outside of it; this method of guiding is termed a "center pilot."

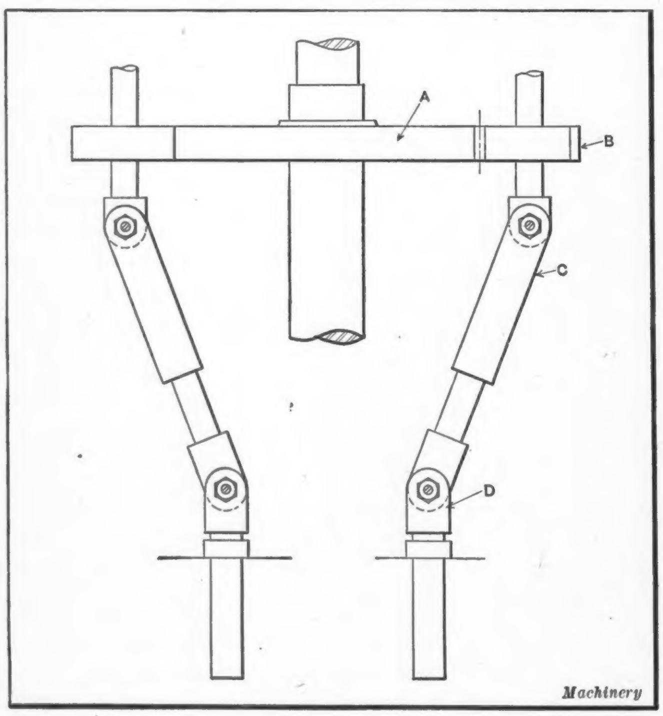


Fig. 19. Universal Joint Drive for Drill Heads

In the center view, two guide rods are placed outside of the drill spindles. This example is similar to the arrangement shown in Fig. 17. It is often quite advisable, however, when making a drill head with guide rods outside of the spindles, to offset these so that the work in the jig can be more readily handled; the right-hand illustration shows such a condition. This is similar to the one shown in the center, except that the guide rods are swung at an angle with the center line so that the operator can conveniently get his hand on the work in the space *C*. These two guide rods are shown held in place by means of check-nuts, while the others shown are merely held in place by driving.

It might be well to mention that a liberal supply of grease should always be packed in the gear chamber of a gear-driven auxiliary spindle drill head and ample provisions should be made for oiling, as otherwise, owing to the high

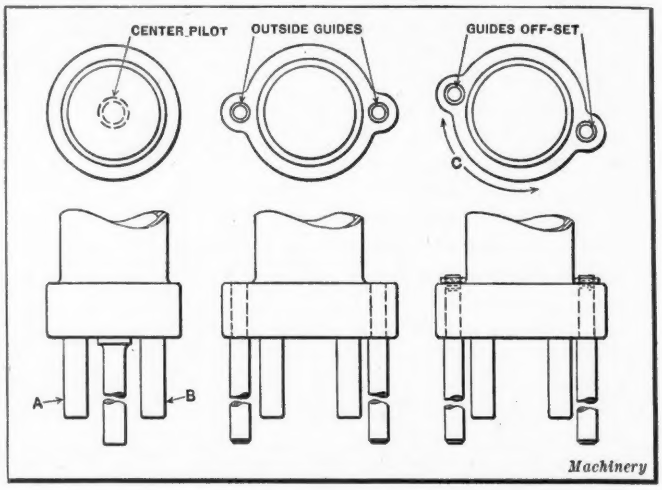


Fig. 20. Methods of piloting Drill Heads

speeds at which they run, the gears are likely to be noisy and wear rapidly; equally important is the method of enclosing, as the gears must be kept free from dirt and chips.

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CHAINS MADE FROM STEEL CASTINGS

Heavy welded chains of either mild steel or wrought iron are being supplanted in many cases by cast-steel chain. Mild steel chain has been found to be either too ductile to retain its form under severe stress or too hard to insure reliable welds when the links have been welded together. Wrought-iron chain, which is made by welding round bars of such iron, bent to suit requirements, has always proved satisfactory. The wrought-iron chain manufacturing capacity of the country is not adequate, however, to fulfill the demands created by the enormous expansion in the shipbuilding program of the country, and the steel-casting chain has been the evolution of the problem.

Cast-steel chains are made successfully and practically either by casting the whole chain integral, or by pouring the metal into separate link molds and then setting these links in alternate molds and pouring the intervening links around those first cast. Chains of almost any size can be, and have been, successfully cast, either integral or by alternate molds, and are now being furnished to the Government in large quantities. The steel used is a special alloy electric steel; it is stated that electric steel is the only grade of steel that can be successfully used and even this steel must be specially heat-treated. The steel casting chains are very strong and of excellent durability. It is essential that steel casting chains be carefully annealed.

* * *

If all the submarine mines produced by the Navy Bureau of Ordnance since this country entered the war were planted at the distance maintained between mines in mining operations at sea, the mines would cross the Atlantic eight times. Through standardization of parts, these mines now cost about one-half as much as mines cost before the war.

TRINITROTOLUOL AND TRINITROPHENOL

PROPERTIES AND CHARACTERISTICS OF TWO OF THE MOST VALUABLE HIGH EXPLOSIVES

Two terms that the war has added to the general vocabulary are T. N. T. and picric acid, the popular names of the high explosives used as shell-bursting charges. While both explosives detonate too suddenly and violently to be serviceable for the propulsion of projectiles, they are exceedingly valuable for causing shells to explode within the enemy's lines, for they withstand the shock of being ejected from the gun and yet may be detonated at the instant desired. In the Spanish-American war, dynamite was tried for this purpose but the pneumatic gun with which it was used was not satisfactory.

Trinitrophenol, or picric acid, has been extensively used in the past for dyeing silk and wool. It is reasonably safe under the circumstances that are supposed to prevail where it is made and handled, but it combines readily with various metals and metallic compounds and forms picrates, which are more sensitive than picric acid itself and may be exploded more readily, with a resulting detonation of the entire mass of picric acid with which the picrates are mixed or otherwise associated.

Trinitrotoluol, or T. N. T., does not form sensitive compounds with metals or metallic compounds and when pure and in good condition, is comparatively insensitive, especially with respect to blows and other mechanical disturbances. To detonate, it is supposed to be necessary to explode a special primer in connection with the main charge. When brought into contact with flame, picric acid and trinitrotoluol take fire and burn, but they do not ordinarily explode, although recently at least one serious explosion is recorded. In this respect they resemble dynamite. If dynamite is ignited, it burns quietly as long as the temperature of the part in the vicinity of the flame is below a certain point, which is termed the critical temperature; but if the dynamite is hotter than the critical temperature, it will explode upon the application of a flame. A study of picric acid and trinitrotoluol suggests that the behavior of these substances with regard to flames may be similar to that of dynamite, each having its own critical temperature, which may be higher or lower than that of dynamite. For this reason, no chance should be consciously taken in connection with the ignition of trinitrotoluol. It has been well said that the function of an explosive is to explode; and this fact should not be forgotten when dealing with any high explosive whatever.

The prominent dangers associated with trinitrotoluol are the danger of fire or explosion in connection with its manufacture or use, and the danger of poisoning from toluol, from nitrous fumes, and from the finished trinitrotoluol.

Toluol, from which T. N. T. is produced, is a limpid, inflammable liquid that has a specific gravity of about 0.87 at ordinary temperatures, boils at + 232 degrees F., and freezes at about — 144 degrees F.; it does not mix with water and, especially when heated, gives off an inflammable vapor that is capable of forming explosive mixtures with air. It has a poisonous action upon the body when its vapors are inhaled or when the liquid itself is absorbed through the skin. The symptoms that it produces are practically identical with those caused by benzol.

Trinitrotoluol can be produced from toluol by a single nitrating operation, but it is more economical to effect the nitration in two or three stages. After the various manufacturing processes the trinitrotoluol is thoroughly washed with hot water and poured into cold water, where it solidifies, taking a granular form as a blast of compressed air is blown through the vessel.

Trinitrotoluol is a crystalline powder of light yellow color which melts at about 178 degrees F. It dissolves in ether and in acetone, but is practically insoluble in cold water, although it dissolves to a slight extent in hot water. It is only slightly soluble in cold alcohol, but at 135 degrees F. alcohol will dissolve 10 per cent of its own weight. The crystals have a specific gravity of about 1.5, and when they are melted and cast in a solid mass the specific gravity is about 1.6. Trinitrotoluol ignites when brought into contact with a flame, or when heated to a temperature variously stated at from 350 degrees F., to about 570 degrees F. It burns with a smoky flame. Thorpe says: "It cannot be exploded by flame. As much as 1000 kilograms (2200 pounds) has burned away quietly in a conflagration, and a rifle bullet may be fired through a solid mass of it without causing explosion." Nevertheless, an explosion, in 1908, in J. W. Leitch & Co.'s works at Huddersfield, England, which injured five men, was demonstrably due to the explosion of a small quantity of trinitrotoluol from exposure to heat; also, an explosion at Witten, in 1906, by which forty-two persons were killed and the factory was practically destroyed, due to a fire; and similarly in Syracuse, in July of the present year. In one experiment when rifle bullets were fired through it, the trinitrotoluol did explode.

When treated properly, trinitrotoluol is probably the least dangerous of all the high explosives, and to detonate it positively and effectively a detonator containing from ten to twenty-five grains of fulminate of mercury is required. Trinitrotoluol is also known as trinitrotoluene, trinitromethylbenzene, trotol, tritone, tolite, trilite, rotyl, trinol and tritolo.

* * *

COMMENT ON THE LABOR PROBLEM

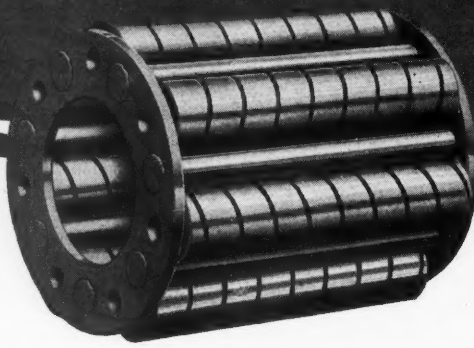
The attention of a manufacturer was called to the article "The Labor Problem of the Small Manufacturing Plant," on page 1046 of the July number of MACHINERY. It is there advocated that something be done to regulate the labor shortage of all labor, and it is implied that the Government, through its labor bureaus, should undertake this regulation. It is stated that manufacturers, in general, should have a right to expect from the Department of Labor the establishment of an authority that could prevent unfair labor market competition. The manufacturer interviewed does not believe that it is necessary for the Government to undertake such control of labor, and does not think that it is in accordance with the best American ideals. He believes that the necessary regulation of labor could be arranged for by an agreement between manufacturers not to hire men from one another unless by mutual agreement. At the present time, this would greatly increase the national efficiency, as a great many men lose one or two days every week because they do not feel the necessity for working full time on account of the high wages paid and the feeling that they can get another job at any time. He believes that it would be better both for the manufacturers and for the toolmakers and machinists if there were not the temptation to change jobs constantly. In the long run, toolmakers and machinists would be better off if they did not change so often, because they would lose less time and their total earnings would be greater. It should not be impossible for the employers in medium-sized cities at any rate to get together and agree not to hire men from one another. This, he stated, would be the best solution of the present problem.

* * *

The high price of many commodities in Europe and America and the increased freight rates for foreign goods have combined to stimulate in China, the domestic manufacture of many lines of goods that heretofore have been imported. Recently, all the engines and machinery, even the propellers, of a new 10,000-ton deadweight ship built by a shipyard in China were made there. Chinese foundry and machine men are also turning out good internal combustion engines of fair horsepower, and are manufacturing a certain amount of electrical goods. Two large shipyards in Hongkong last year turned out ocean-going vessels to the amount of about 35,000 tons deadweight capacity.

Roller Bearings

For Machine Shop Equipment—2



Fifth of a Series of Articles on Bearings. By Edward K. Hammond, Associate Editor of Machinery

In this series of articles discussing the design and lubrication of bearings for machine shop equipment, the first article dealing with the application of roller bearings was published in the October number. It presented general information concerning the features of roller bearings and described the best current practice in designing mountings and providing means for efficient lubrication. After completing this general discussion, specific information was given concerning the best methods of applying different types of roller bearings in machine tools, countershafts, lineshaft hangers, and other equipment used in machine shops. The article which appears in this number of Machinery continues the description of specific roller bearing applications and also gives general information concerning the best practice in lubricating bearings of this kind. It is the final article of the series.

Features of the Timken Roller Bearing

Roller bearings manufactured by the Timken Roller Bearing Co., of Canton, Ohio, are provided with tapered rollers and races, which adapt them for carrying combined radial and thrust loads. In addition, this tapered form adapts the bearings for use in mountings which provide means for taking up any small amount of wear which may develop after they have been placed in service. This feature adapts these roller bearings for carrying the spindles of machine tools, where it is necessary to maintain a tight fit. These bearings are made in a variety of different sizes, which have rollers with slightly different taper angles. Owing to the effect of these slight differences in taper upon the function of each size of bearing in carrying its load, the Timken Roller Bearing Co. makes a practice of recommending the specific type of bearing for each different class of service. Stated another way, the Timken bearings are not manufactured in standard sizes which are sold on the purchaser's specification. The company is anxious to have the proper size and type of bearing used in order that the best possible service may be obtained by the user, and it is for this reason that its engineering department prefers to make recommendations for each new class of service in which the bearings are used.

From Fig. 15, it will be apparent that the inner race of the bearing is provided with a shoulder *A* against which the large ends of the rollers abut. The purpose of this design is to have the rollers held in such a way that the tendency for them to slide up on the taper of the inner race, due to pressure exerted by the thrust load, may be effectually overcome. At the small end of the rollers there is a nib *B*, and when the bearing is new, the ground shoulder on this nib stands away from rib *C* on the bearing by approximately 0.003 inch. The reason for providing this clearance is that, after the bearing has been in service for a short length of time, the very small ridges which are left on the surfaces of the rollers and races after the final polishing operation has been completed are rolled down, so that each roller assumes a position higher up on the taper of the inner race. When this result has been accomplished, the ground shoulder on nib *B* engages the corresponding surface on rib *C*. This not only gives the bearing an additional capacity for supporting thrust loads, but it also assists in keeping the rollers in accurate alignment with the raceways. Owing to the slight amount of frictional resistance which exists when the large end of the rollers is in contact with rib *A*, there would be a tendency for the large end of each roller to be retarded and thus throw all of the rollers out of alignment with the raceways, if a similar frictional resistance were not provided by having nib *B* roll in contact with rib *C*. Attention is called to the fact that the only function of the pressed-steel cage in which the rollers are held is to guide the rollers during the time that they are in the zone of no load, and have them in proper alignment as they come into the zone where the load of the bearing must be supported.

These bearings are assembled with the rollers held in a pressed-steel cage, so that the inner race (or cone) of the bearing, the rollers and the retaining cage constitute a self-contained unit, making the complete bearing consist of two essential parts, namely, this unit and the outer race, or cup. An explanation has already been given of the way in which roller bearings may be packed in a sufficient supply of lubricant to last for several months, and this general feature of roller bearings is, of course, one of the important advantages secured through the application of Timken bearings in machine shop equipment. In addition, there is the practical freedom of the bearings from wear, and a substantial improvement in transmission efficiency through the substitution of the rolling friction of a roller bearing in place of the sliding friction of a plain bearing.

Results Obtained with Roller Bearings Carrying Grinding Machine Spindles

At the plant of the Studebaker Corporation in Detroit, Mich., cylinder grinding machines which are used in the manufacture of automobile engines are required to run at from 19,000 to 20,000 revolutions per minute, in order to obtain the required cutting speed for the abrasive wheel. Where plain bronze bearings were used to carry the wheel-spindles running at this high speed, it was found necessary to adjust the bearings every four days in order to compensate for wear and maintain the required tightness of fit for the bearings. In order to improve this condition of operation, Timken roller bearings were substituted in place of the plain bearings, and this was the means of effecting a substantial improvement in operating conditions. After the roller bearings had been in use for about four months it was found necessary to make the required adjustment to take up a slight amount of lost motion which had developed; and since doing this, the bearings have run for four years without showing any appreciable sign of wear. This statement applies to results obtained through the use of roller bearings for carrying the spindles of fifty cylinder grinding machines. Where these anti-friction bearings are employed, there is no

noticeable slowing up of the wheel due to resistance offered when it is brought into contact with the work, and owing to the avoidance of the necessity of making constant adjustments of plain bearings, and the possibility of maintaining a uniformly high cutting speed, an increase of 50 per cent has been made in the production obtained on these fifty cylinder grinding machines. A further substantial saving was also accomplished through the possibility of releasing 50 per cent of the tool-room force which had formerly been employed in adjusting plain bearings.

Thread Milling Machine Spindle Mounted in Roller Bearings

In Fig. 17 is shown the design of mountings for the spindle of a thread milling machine which is mounted in Timken roller bearings. This spindle is driven by a spiral gear, so that the bearings are subjected to a combined thrust of the spiral gear and pressure of the cutting tool, in addition to the radial load which they are required to carry. Evidently, it would be impractical to use any form of roller bearing for this service which was not provided with tapered rollers and races so that provision could be made for carrying the thrust. In this case, the spiral gears run in a bath of oil, the level of which is raised above the gears so that the roller bearings are also submerged. It will be seen that the casing is provided with packings A, which afford an oil-tight joint. In any form of machine tool spindle it is necessary to have tight-fitting bearings in order to obtain the required degree of accuracy in the work. This result may be obtained with Timken bearings owing to the possibility of adjusting the lateral position of the inner and outer races relative to each other, in order that the very slight amount of lost motion which develops owing to wear may be taken up. In the present case it will be seen that at each end of the spindle there is an adjusting nut B, and when it is necessary to adjust the bearings these nuts B are screwed up against the inner races, causing the races to be pushed inward. Owing to the shoulder on the inner races, this lateral movement also carries the rollers inward so that they are moved to a position higher up on the taper of the outer race, thus taking up any lost motion. Back of the adjusting nuts B it will be seen that lock-nuts C are provided; after the adjustment has been made these lock-nuts C are screwed up, and then nut-locks D are bent over the flats on the adjusting nuts and lock-nuts, to provide for maintaining exactly the proper adjustment.

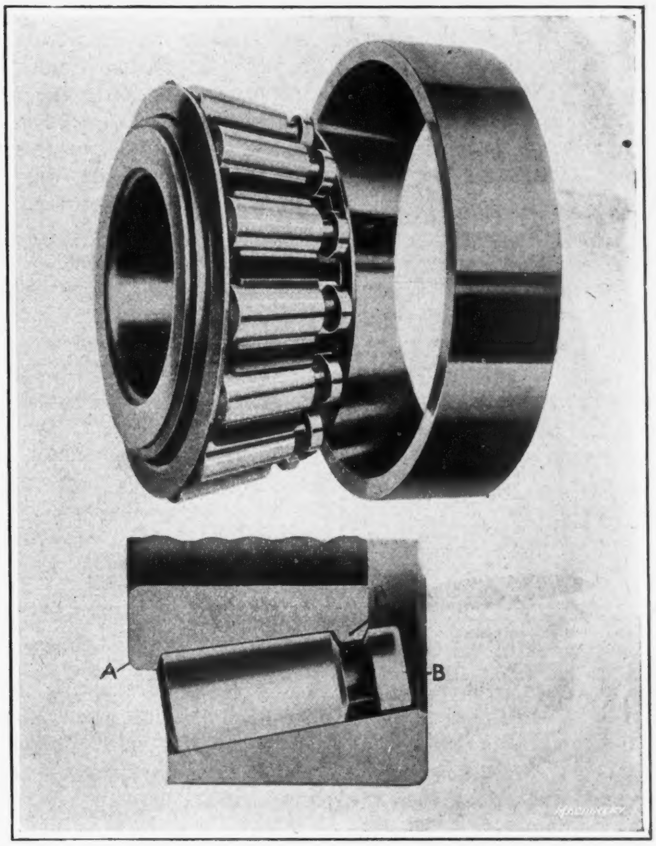


Fig. 15. Roller Bearing in which Rollers are held in Retaining Cage

Roller Bearings for Milling Machine Table Feed-screw

In Fig. 18 there is shown the way in which Timken roller bearings are employed to support the table feed-screw of a hand milling machine. By using anti-friction bearings for this purpose the action of the feed-screw is made very sensitive, thus enabling accurate settings of the table to be easily obtained. Attention is called to the fact that the mounting is so designed that at each end of the spindle the roller bearing is enclosed in a case which may be packed with a sufficient quantity of lubricant to last a couple of months. In this way the bearings are able to operate efficiently without requiring constant attention. When it is necessary to compensate for lost motion, this is accomplished by screwing up adjusting nuts A, which force the inner races inward, thus carrying the rollers to a higher position on the taper of the outer races. The required adjustment is then permanently maintained by means of lock-nuts B and nut-locks C, the arrangement being similar to that which has already been described in connection with the thread milling machine.

Roller-bearing Lathe Center

On heavy-duty lathes, where the weight of the work and pressure exerted by the cutting tools bring a considerable load to bear upon the centers which carry the work, trouble is sometimes experienced through the heating of the centers. It is a familiar sight to see the tapered centers on lathes used for such service quite badly burned or smoking considerably while in use. Through the application of roller-bearing lathe centers, of the type shown in Fig. 16, difficulty of this kind is effectually overcome. It will be apparent from this illustration that the center consists of a tapered collar A which fits into the work. The inner bearing race B is a press fit on the pilot inside of this collar; while the outer race C is pressed into the socket at the end of the shank. In this case, pressure exerted by the tailstock spindle is depended upon to maintain a uniformly tight fit between the rollers and races of the bearing, and attention is called to the fact that threaded collar D is merely employed to retain collar A in position. Normally, the rollers and races of the roller bearing are a loose fit, but when pressure is applied on collar A this collar is pushed toward the right, thus taking up all lost motion in the bearing. At E there will be seen a threaded plug. All of the space in the bearing mounting is packed with grease, and from time to time, plug E is screwed up to insure having grease forced into intimate contact with all parts of the bearing. This lubricating device operates in essentially the same way as the familiar form of compression grease cup.

Roller Bearing Mounting for Rolls of Straightening Machine

In steel mills engaged in the production of cold-drawn shafting and screw stock it is necessary to straighten the product after it has been pulled through the drawing dies. Readers of MACHINERY are familiar with machines used for this purpose, which consist of rolls between which the cold-drawn steel bars are passed. In order to obtain the desired result, it is necessary for the straightening rolls to exert a high pressure on the work, and consequently the bearings which support these rolls are subjected to high pressure. Fig. 19 shows the way in which Timken roller bearings are employed for supporting straightening rolls, and for this class of service the anti-friction properties of the bearings and their practical freedom from wear make them especially well adapted for the purpose. In this installation the method of mounting the bearings, and the provision made to compensate for wear have been worked out in rather a different way

from that illustrated and described in preceding examples. In this case both of the inner races are pressed onto the shaft, and both of the outer races are a press fit in the straightening roll A. In order to compensate for wear, adjusting nut B is tightened, with the result that pressure is applied against the end of the inner race, thus causing the rollers carried by this race to be pushed higher up onto the taper of the outer raceway of the bearing. After making compensation for lost motion, additional pressure applied by adjusting nut B causes straightening roll A to be moved slightly toward the left, with the result that the outer raceway of the left-hand bearing is moved over. This movement is, in turn, imparted to the rollers carried in this bearing, thus causing the rollers to be forced higher up onto the taper of the inner raceway. A brief consideration will make it apparent that this adjustment is the converse of that employed in previous cases, where movement of the inner race and rollers moves the rollers higher up onto the taper of the outer raceway.

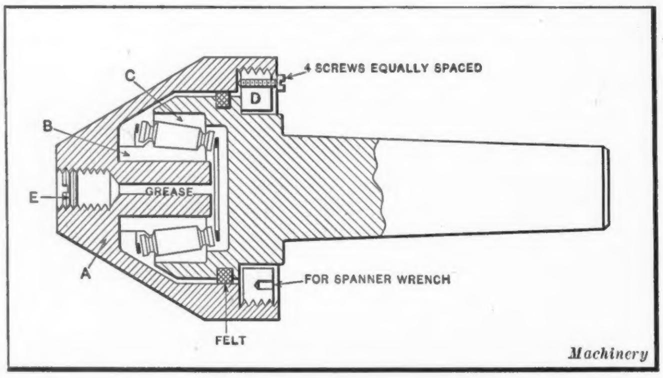


Fig. 16. Roller-bearing Lathe Center designed to carry Thrust exerted by Cutting Tool when Heavy Cuts are taken

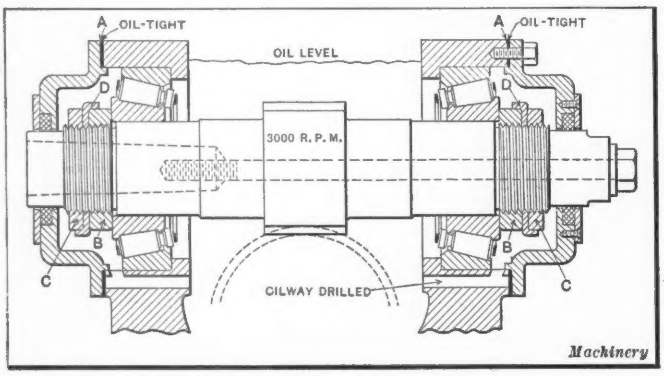


Fig. 17. Thread Milling Machine Spindle with Adjustable Roller Bearings that carry Thrust of Spiral Gear and Pressure of Tool

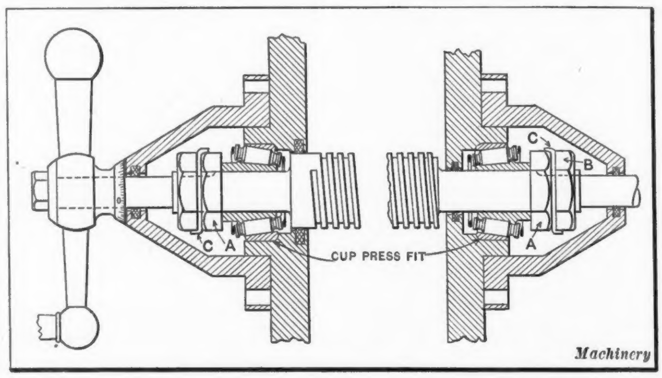


Fig. 18. Application of Roller Bearings on Table Feed-screw of Hand Milling Machine

The method of lubricating these bearings is quite similar to that employed in the lathe center shown in Fig. 16. In the present case it will be seen that a compression grease cup C is provided, from which lubricant is forced through ducts D to the space in the bearing mounting. At the time the bearings are assembled, this space is completely filled with grease and from time to time the compression grease cup C is tightened up to assure maintaining the lubricant in intimate contact with all parts of the body.

Roller Bearing Mounting for Hot Saw Spindle

In the operation of metal-sawing machines, the high speed at which the spindle is required to rotate makes the advantages secured through the application of anti-friction bearings a matter of particular importance. It will also be apparent that the practical freedom of these bearings from tendency to wear under normal conditions of service is a matter of considerable importance. Attention is called to the fact, however, that in order to employ roller bearings for supporting the spindles of metal-sawing machines—or in fact, the spindles of any form of machine tools—provision must be made for taking up the very small amount of lost motion which develops owing to the wear of the rollers and races of the bearings. In Fig. 21 there is shown the way in which Timken roller bearings are employed to support the spindle of a hot saw, the application of roller bearings in this case being made possible through the tapered form of rollers and raceways which enables compensation to be made, in order to maintain a tight fit of the bearings at all times. The way in which this adjustment is made is as follows:

At the end of the housing which carries the outer raceway of the bearing at the left-hand end of the spindle, there is an adjusting nut A, and when this nut is tightened it results in drawing housing B and the raceway carried by this housing toward the left. The ribs on the inner raceway of the bearing restrain the rollers against lateral movement, and so lost motion is taken up by drawing the outer race toward the left until all play in the bearing has been taken up. After this result has been obtained, further tightening of nut A results in drawing the spindle and inner raceway of the bearing at the right-hand end of the spindle toward the left. The ribs on the inner raceway cause this movement also to carry the rollers toward the left, with the result that these rollers assume a position higher up on the taper of the outer raceway of the bearing. From this it will be apparent that by simply tightening nut A, any lost motion which exists in the bearings at both ends of the spindle is taken up. After the required adjustment has been obtained, lock-nut A is held in place by means of the nut-lock which is secured by cap-screws C.

Owing to the severe conditions of service under which hot saws are required to operate, users of this type of machinery often have trouble in maintaining the bearings in the proper working condition. Machinery of this class often runs in a dust-laden atmosphere, and the high speed, together with the high temperature of the material being cut, combines to create a condition which is very hard on the bearings. In this service anti-friction bearings give very satisfactory results, provided the necessary means are furnished for excluding dirt. To state the case in a little

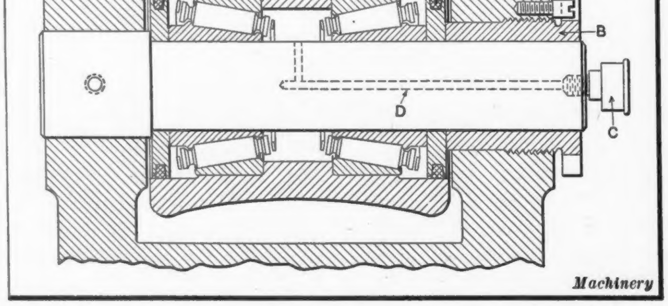


Fig. 19. Roller Bearing Mounting for Rolls of Straightening Machine

different form, great care must be taken to so design the bearing mountings that they are perfectly dustproof. Fig. 20 shows the spindle of a hot saw which is mounted on Hyatt roller bearings, and in this illustration it will be apparent that instead of allowing the rollers to run directly upon the spindle, inner raceways are furnished. In general features, the design of the bearing mountings used in this case are similar to those which have already been described in connection with other applications of Hyatt roller bearings. The interesting point is that this type of roller bearings has been used on hot saws for a period of over one year without requiring anything beyond the usual care in providing a fresh supply of lubricant at intervals of about three months.

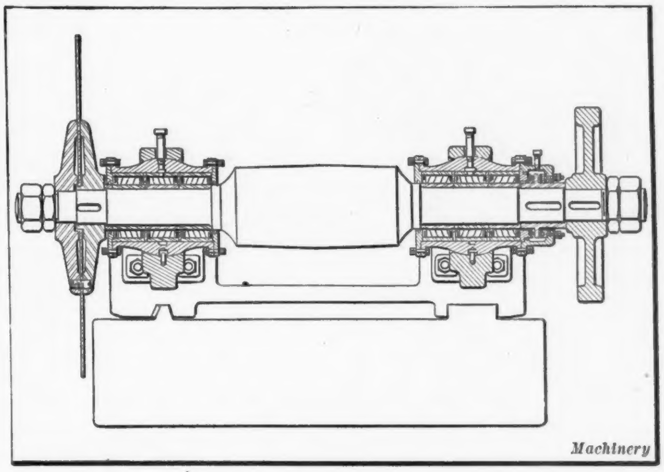


Fig. 20. Application of Hyatt Roller Bearings for carrying the Spindle of a Hot Saw

Application of Roller Bearings in Grinding Machine Construction

In order to provide the requisite cutting speed for the abrasive wheel of a grinding machine, it is necessary to drive the spindle at a number of revolutions per minute which will give the wheel a peripheral speed of approximately 5000 feet per minute. This necessitates the provision of suitable means for supporting driving shafts, etc., which run at high rotative speeds. Experienced designers of grinding machines do not believe that even those types of roller bearings furnished with means of adjustment for wear are adapted for carrying the wheel-spindle, because it is necessary to have the bearings used for this purpose an extremely close fit; otherwise, the presence of lost motion will result in the production of inaccurate and poorly finished work. For supporting driving shafts and other members of grinding machines, however, the application of roller bearings is the means of effecting a substantial saving in the amount of power consumed in operating the machine. Also, bearings of this type are especially suitable for high rotative speeds, owing to their freedom from friction.

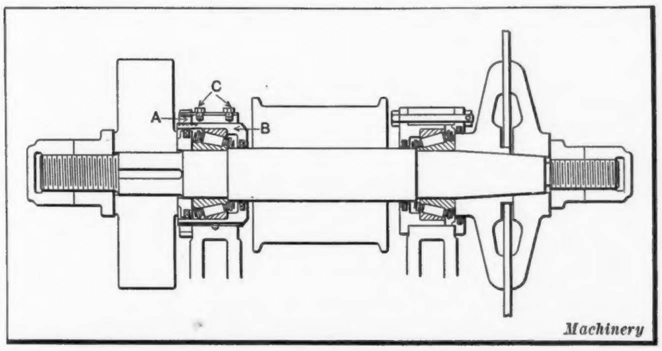


Fig. 21. Hot Saw Spindle equipped with Adjustable Roller Bearings. The Application of Roller Bearings is made possible by the Tapered Form of Rollers and Raceways

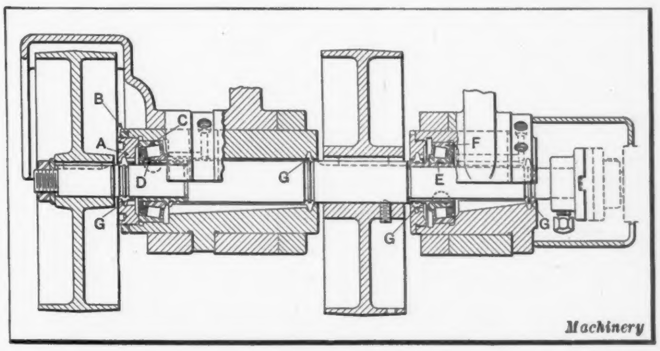


Fig. 22. On High-speed Machinery all Bearings must fit Tight to avoid Vibration. This Grinding Machine Driving Shaft is carried in Tapered Roller Bearings having Means for taking up Lost Motion

Roller Bearings for Carrying Driving Shaft of Grinding Machine

On the No. 11 plain grinding machine built by the Brown & Sharpe Mfg. Co., of Providence, R. I., the main driving shaft is mounted in roller bearings. This shaft runs at about 900 revolutions per minute, and at this speed the use of anti-friction bearings is the means of effecting a substantial saving in power consumption. It was the opinion of this company's grinding machine designers, however, that the only form of roller bearing which would give satisfaction under these conditions of service would be some type in which provision is made to compensate for any small amount of lost motion that develops between the rollers and raceways owing to wear. After looking over the different types of commercial bearings that are available, preference was finally given to a bearing in which tapered rollers run in raceways designed in such a way that a longitudinal adjustment of one race in relation to the other results in pushing the rollers up on the taper of the raceways in order to take up any lost motion which may have developed as a result of wear of the rollers and races.

Reference to the cross-sectional view shown in Fig. 22 will make it apparent that the mounting has been designed with especial reference to the provision of means for easily taking up lost motion in the bearings whenever such adjustment is found necessary. Attention is first called to the form of raceways in which the rollers are carried. It will be seen that the inner races are provided with shoulders at each end, so that the rollers are restrained against endwise movement. This adapts the bearing for carrying a thrust load as well as a radial load. When it is desired to make adjustment to compensate for wear, this is accomplished by pushing over either the inner or the outer raceway and holding the position of the other race constant, so that the rollers find a position higher up on the taper of the raceways In this way, any lost motion which has developed through wear of the races and rollers may be easily taken up. With such an arrangement, a tight-fitting bearing can be maintained at all times, and the user of a machine with bearings equipped in

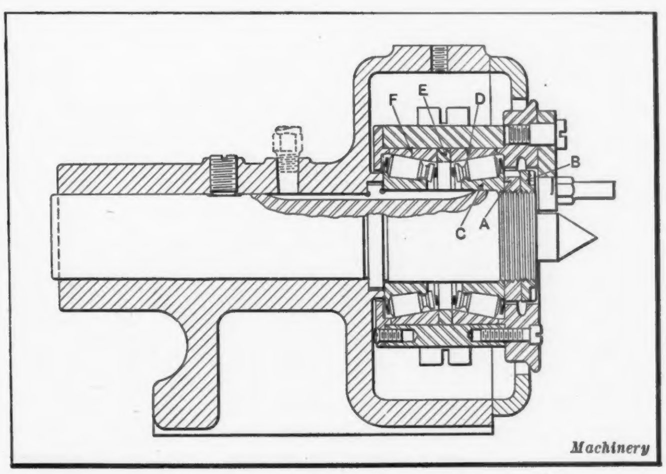


Fig. 23. Application of Tapered Roller Bearings for carrying Headstock Spindle of Grinding Machine

this way is also able to take advantage of the high transmission efficiency of anti-friction bearings.

With the preceding statement of the way in which adjustment of a roller bearing of this type is accomplished, we are ready to explain the means that were provided, when working out the design of the bearing mountings on this grinding machine driving shaft, for taking up wear in the bearings as rapidly as it develops. Adjustment of both bearings is accomplished by means of nut *A*, which is threaded into the housing that carries the bearing at the left-hand end of the shaft. When the presence of lost motion has been detected, and it is necessary to adjust the bearings to make the required compensation, the first step is to back off lock-nut *B* so that nut *A* can be tightened. Tightening nut *A* results in forcing outer race *C* up onto the taper of the rollers, and as a result of this movement, the rollers impart a thrust against the shoulder on inner race *D*. It will be seen that this inner race abuts against a shoulder on the driving shaft of the grinding machine, and as a result of the thrust developed by tightening nut *A*, the entire spindle is caused to move to the right. Owing to movement of the shaft caused by tightening nut *A*, inner race *E* of the bearing at the right-hand end of the shaft causes the rollers to be pushed to the right, with the result that they move up onto the taper of outer race *F*.

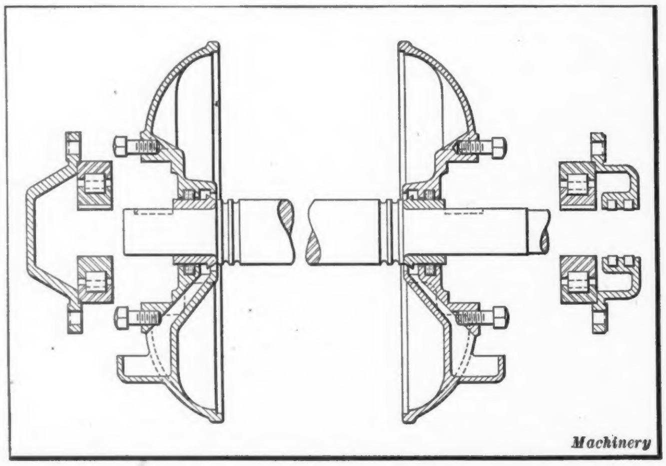


Fig. 24. Roller Bearings used to support Armature Shaft of Electric Motor to provide for reducing Air Gap and maintaining it Constant

It will, of course, be fully understood that the amount of wear which develops in these roller bearings is extremely small, so that only a very slight movement of nut *A* is required in order to effect the desired compensation. With any adjustable bearing of this type, particular care must be taken not to tighten the bearing to such an extent that movement of the rollers in their races is at all restricted. To give efficient results, the rollers must run freely in their races, but there must be no lost motion between the rollers and raceways. After the desired adjustment of the bearing has been obtained, lock-nut *B* is tightened against the face of the bearing mounting in order to clamp nut *A* in the proper position. Attention is called to the fact that the bearing mountings are provided with grease grooves *G* which effectually prevent abrasive dust from finding its way into the bearings. This is an important feature of the design of all bearings on grinding machines, where trouble is likely to be experienced through scoring the bearings with dust from the wheel that finds its way into the bearings.

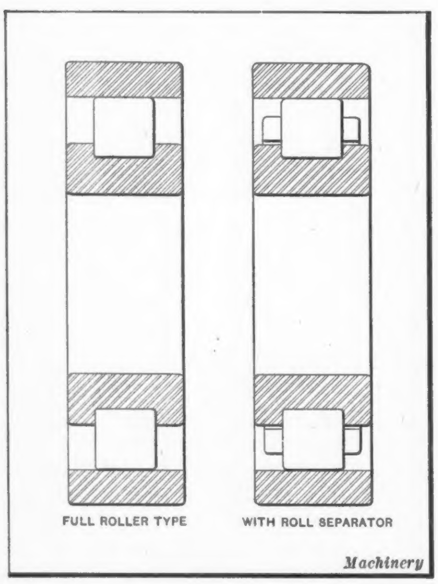


Fig. 25. Two Types of Radial Roller Bearings which are adapted for carrying Heavy Loads where Space is Limited

Roller Bearings in Headstock of Grinding Machine

There is shown in Fig. 23 the mounting developed for use in the headstock of a Brown & Sharpe grinding machine which is equipped with roller bearings of the same type as those described in connection with the main driving shaft illustrated in Fig. 22. In the present illustration it will be seen that two roller bearings are placed side by side in the headstock, with the tapers of the races and rollers running in opposite directions. This affords a convenient way of adjusting the bearings to compensate for wear. It will be seen that the end of the spindle is threaded to receive an adjusting nut *A* and lock-nut *B*. In order to make adjustment, lock-nut *B* is backed away so that nut *A* can be tightened up against inner race *C*. Pressure applied in this way forces race *C* to the left, as a result of which the rollers are pushed up onto the taper of outer race *D*. Lateral movement of this outer race is transmitted through spacing collar *E* to outer race *F* of the other bearing, which is pushed up on the tapered rollers. In this way simply tightening adjusting nut *A* is the means of compensating for lost motion which may have developed in either or both of the bearings. Should it happen that one bearing has worn more than the other, the amount of adjustment made in each bearing is always proportional to the amount of wear, so that exactly the desired compensation is made in each of the bearings.

Application of Roller Bearings in Electric Motors

Induction and direct-current motors used for industrial work operate at very high speeds, and, therefore, the use of efficient anti-friction bearings for supporting the armature shaft is of exceptional importance. Fig. 24 shows how "Rollway" roller bearings manufactured by the Railway Roller Bearing Co., of Syracuse, N. Y., are used to carry the armature shaft of a five-horsepower Westinghouse electric motor. Advantages claimed for roller bearings used for this purpose are that they maintain a constant air gap between the rotor and stator, and that this air gap may be reduced to at least half what is possible where plain bearings are used, because owing to the freedom of roller bearings from wear, there is no danger of the armature shaft being allowed to drop sufficiently to cause trouble. The time required to pay frequent attention to the bearings, and for inspection, oiling, and rebabbitting is also saved. It is stated that an ounce of oil for each bearing per horsepower per year, is the record for "Rollway" bearings supporting the armature shafts of induction motors operating at 900 revolutions per minute, ten hours per day. It is sufficient to apply oil at intervals of from three to six months, and the bearings require inspection only once a year. It

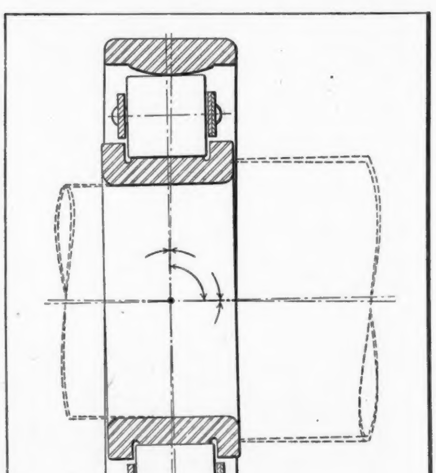


Fig. 26. Radial Roller Bearing provided with Means of compensating for Lack of Shaft Alignment

is stated that power saved through the substitution of these roller bearings for plain bearings will not ordinarily amount to more than 4 per cent of the input of the motor, but additional savings resulting from reduction of attention required in lubrication, inspection, rebabbitting, etc., will, in many cases pay for the bearings within a period of one year after their installation.

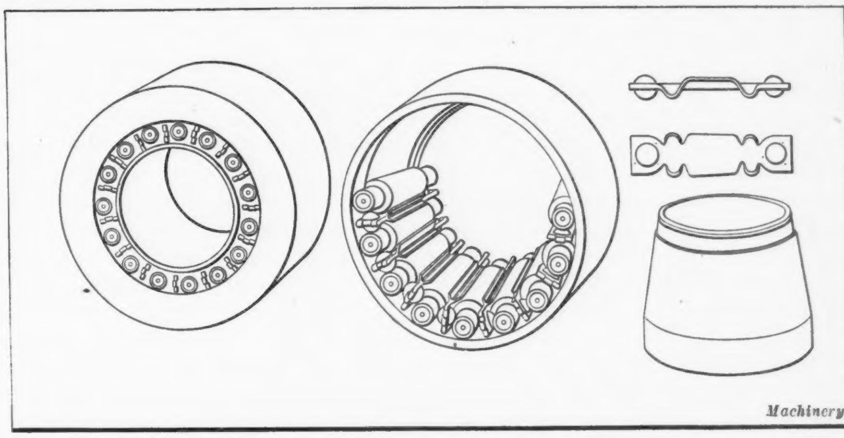


Fig. 29. Tapered Roller Bearing with Separator composed of Individual Units placed between Adjacent Rollers

Radial Roller Bearings

Mention has been made of the fact that owing to the line contact which exists in a roller bearing, its capacity for supporting a load is greater than that of a ball bearing of about the same size, where there is point contact between the balls and races. To fulfill conditions requiring heavy loads to be supported in positions where space is limited, the Ball & Roller Bearing Co., of Danbury, Conn., has recently developed the radial type of roller bearing which is illustrated in Fig. 25. It is particularly intended for use in places where there is insufficient space to mount a ball bearing of the required size to support the load. Bearings of this type are made in two styles, one of which is known as a full roller style, while the other is provided with a roller separator. It will be seen that the inner race is channeled to form a groove or track for the rollers, but the outer race is a straight cylinder, allowing the rollers to assume their correct position in this race. The separator or roller cage is made of bronze and carefully machined all over. It is designed in such a way that the cage floats freely with the rollers without any rubbing friction between the cage and rollers.

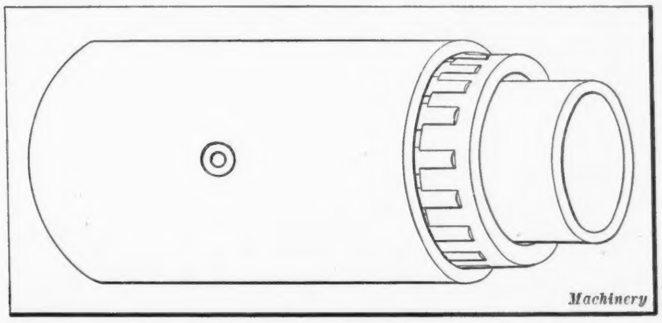


Fig. 27. Roller Journal Bearing provided with Both Inner and Outer Races

For mounting bearings of this type, the method of procedure differs somewhat from that employed with radial ball bearings, and attention is called to the following points: It is essential that the tracks of the rollers in the inner and outer races should be perfectly parallel with each other. The outer race should be a good fit in the housing and free from lost motion, and it must be located exactly opposite the inner race so that the paths of the rollers are in proper alignment. Obviously, no side thrust can be imposed upon these bearings, even to locate the shaft endwise. Therefore, both the inner and outer races must be press fits, and shoulders should preferably be provided, against which the races are located in their respective positions. Care must be taken to see that the races are not distorted during the process of mounting.

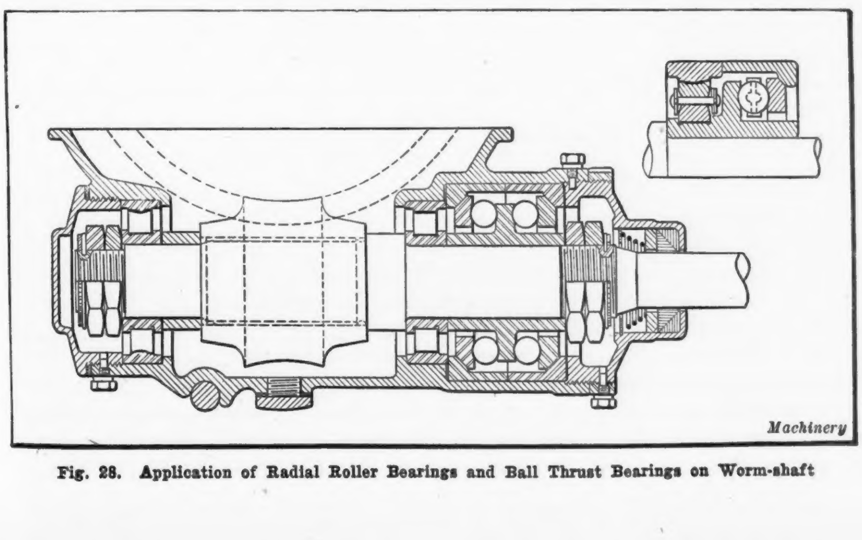


Fig. 28. Application of Radial Roller Bearings and Ball Thrust Bearings on Worm-shaft

Where it is merely desired to provide end location for the shaft, a plain thrust collar will often serve the purpose. A bearing of this type may be used in place of a plain bearing and saves a lot of expensive work in scraping the bearing to an accurate fit.

For use in supporting heavy radial loads where economy of space is not a matter of particular importance, the Ball & Roller Bearing Co. manufactures the type of radial roller bearing shown in Fig. 27. The features of this bearing will be fairly apparent from the illustration without requiring more than a very brief description. It will be seen that the rollers are supported by a cage which distributes them uniformly and maintains accurate alignment between the rollers and raceways in which they run. Steel sleeves are provided to furnish both inner and outer tracks or raceways for the rollers.

Roller Bearing that Compensates for Shaft Deflection

In order for a roller bearing to give efficient service in the transmission of power, it is highly important for the races and rollers to be maintained in accurate alignment with each other. Where any lack of alignment exists, the load will not be uniformly distributed over the entire length of the rollers and races, with the result that the transmission efficiency of the bearing will be seriously impaired. In some cases, trouble is experienced in the operation of roller bearings through deflection of the shaft carried by them. Some types of bearings have provision made in their design to compensate for such variations in shaft deflection, and in Fig. 26 there is shown a roller bearing made by the Norma Co. of America, 1790 Broadway, New York City, in which provision of this kind has been made. It is generally understood that there is point contact between the balls and races in a ball bearing, and that line contact exists between the rollers and races of a roller bearing, although these theoretical conditions in both types of bearings are somewhat modified due to deflection of the steel bearing members when placed under load.

In a roller bearing with the usual line contact, it would be difficult if not impossible to afford means of compensation for variations in alignment of the shaft, due to different conditions of load, etc., but in the Norma bearing shown in Fig. 26 it will be seen that the outer race is made slightly convex so that the contact between the outer race and rollers is more like that which usually exists in a ball

bearing. With a roller bearing of this type, any variation in the alignment of the shaft carried by the bearing is automatically compensated for, because such variations simply result in tilting the inner race and rollers so that the rollers come into contact with the convex outer race at a point a little farther around the arc of the raceway. Such variations in alignment do not cause any trouble from cramping the rollers or from destroying the proper contact between the races and rollers. As a result, the Norma roller bearing can operate efficiently in cases where the shaft is likely to be deflected somewhat under shock or overload or where there are slight errors in alignment or inaccuracies in the mounting of the bearing. Before the bearing is placed under load, there is point contact between the rollers and outer race, and line contact between the rollers and inner race; but when the load is applied, deformation of the bearing members, due to elasticity of the steel, transforms the point contact into a long elliptical shaped surface contact which greatly increases the load-carrying capacity of the bearing.

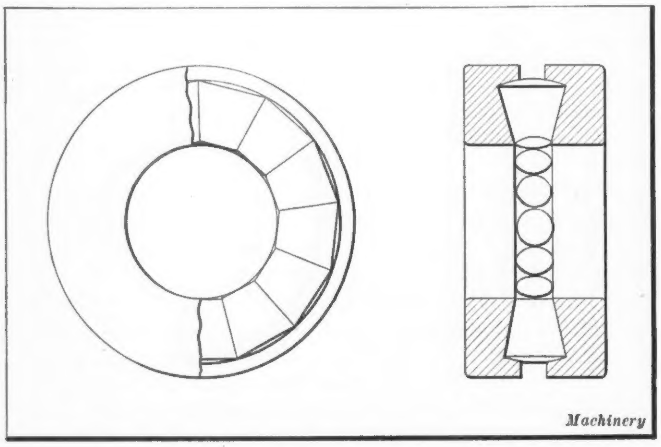


Fig. 30. Roller Thrust Bearing provided with Tapered Rollers which give theoretically Perfect Rolling Action

Each of the rollers in this bearing turns on a slender stud held in the roller cage. The sole function of these studs and the cage is to guide the rollers from the unloaded side of the bearing around to the point where they again come under load, and to properly space the rollers around the bearing. None of the bearing load comes on the studs or cage, and frictional resistance between the studs and rollers is said to be very small. It will be apparent that this bearing is only adapted for supporting radial loads, and in cases where it is necessary to provide for carrying a combined radial and thrust load, such as exists on a shaft supporting the worm of a worm and wheel combination, bearings of this kind should be used in conjunction with a ball thrust bearing, or any other type of bearing that provides endwise location for the shaft. Such an installation is shown in Fig. 28, where it will be seen that a double thrust bearing is used to provide for carrying a thrust load which may be operative in either direction. Attention is called to the fact that the Norma Co. of America also makes roller bearings of this type with a ball thrust bearing attached in the same unit, as shown in detail in the upper right-hand corner of this illustration. The functions of such a bearing are the same as those for the combination used to carry the worm-shaft to which reference has just been made.

Combination Radial and Thrust Roller Bearings

In Fig. 29 there is shown a roller bearing furnished with tapered rollers, which is adapted for carrying a combination radial and thrust load on a shaft. This bearing is made by the Regina Co., of Rahway, N. J. Loads applied endwise on the shaft may be as great as 20 per cent of the capacity of the bearing for supporting radial loads. It will be apparent from the illustration, that at each end of the section of the rollers which engages the raceways of the bearing, there are furnished shoulders which abut against a shoulder at the side of the track in the outer race. When end thrust is applied on the shaft, not only does the tapered form of the rollers afford capacity for supporting such a load, but, in addition, the shoulders on the rollers are pushed up against the shoulder in the outer race, thus adding substantially to the bearing's capacity for carrying a load which is applied endwise on the shaft.

Another point of interest in connection with this roller bearing is the design of the separators which space the rollers around the raceways. Instead of having a cage made in one integral piece, the separator for this bearing is made in individual parts which go between each pair of rollers. It will be seen that each of these separators consists of two steel clips which are pierced at each end so that when the two clips are assembled together, back to back, the holes form pockets to hold hardened steel balls. These balls engage pilots which are machined at each end of the bearing rollers, thus distributing the rollers uniformly around the bearing, and at the same time accomplishing this result with very little frictional resistance.

It will be seen that two steel clips constitute the body of each separator. Each of these clips has a shallow cradle formed in it, that fits over the roller against which the clip is mounted. It must be distinctly understood, however, that the only parts of the separator which come into positive contact with the rollers are the hardened steel balls; the clips simply float against the rollers and perform no other function except that of supporting the steel separator balls in the desired positions. In assembling a bearing of this type, alternate spacing clips and rollers are assembled in the outer raceway, until finally, the entire complement has been put into place with the exception of the last clip. When this clip is pushed into position by applying pressure with the thumb and index finger, it applies sufficient spring pressure to hold all of the rollers and separators in place in the outer raceway, as shown in the illustration, thus making a virtually self-contained unit.

Roller Thrust Bearings

In working out the design of roller thrust bearings, provision must be made to compensate for the difference in lateral speed of the inner and outer ends of the rollers, owing to the different radii of the circles around which they travel. Also, for theoretically correct operation, the rollers should be of conical form, because cylindrical shaped rollers will tend to travel on a tangent to the circular raceway instead of following the circle. Fig. 30 shows a roller thrust bearing made by the Bantam Ball Bearing Co., of Bantam, Conn., which is furnished with rollers and raceways designed according to the principles which have just been mentioned. These bearings are adapted for carrying the thrust of worms and other forms of mechanism used on heavy-duty machine tools. They are made to order to meet the customer's requirements for specified conditions.

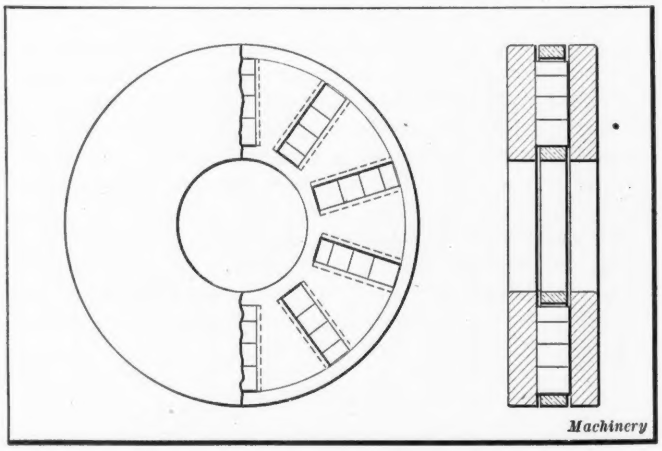


Fig. 31. Roller Thrust Bearing with Cylindrical Rollers. Theoretically, the Design of this Bearing is Wrong, but it is said to give Good Results under Actual Conditions of Operation

Fig. 31 shows another type of roller thrust bearing made

by the Bantam Ball Bearing Co. Here it will be seen that flat races carry rollers of cylindrical form; and in order to compensate as far as possible for the variation in speed of rotation between the inner and outer ends of the rollers, the practice of dividing each roller into short sections has been adopted. By this means, slippage between the rollers and raceways is reduced to a minimum. It is admitted that the construction of this bearing is theoretically wrong, but experience has shown that it is capable of giving satisfactory service. When it is desired, spherical-seated thrust washers may be placed under both this bearing and the bearing shown in Fig. 30, equipped with conical-shaped rollers, in order to enable compensation to be made for lack of alignment. The use of these aligning washers is particularly recommended in the case of bearings which are to be used for extremely heavy service, in order to insure an even distribution of the load.

Roller Bearings with Staggered Rollers

In the design of roller bearings which are made by the Hart Roller Bearing Co., 512 Main St., East Orange, N. J., a different principle of construction has been worked out from that used by other manufacturers of roller bearings. In the radial roller bearing shown in Fig. 32, the staggered rollers are carried on alignment rolls which take the place of the idler rolls in the thrust bearing, and which are carried at their ends by the retainer rings, in which they revolve freely. This arrangement maintains the staggered position of the rollers, and as the rollers are all of the same width they mesh together as shown in Fig. 32.

By referring to the thrust bearing shown in Fig. 33 it will be seen that each roller is composed of alternate roller sections and idlers which are carried on pins that are held at each end by retaining rings. Both the roller sections and idlers are free to rotate on the pins by which they are carried. The staggered arrangement of the rollers which is employed in these bearings is made possible by having both the rollers and idlers of the same width, so that the roller sections mesh together, as shown in the illustration. Several important advantages are claimed for this form of roller bearing construction, among which the following may be mentioned:

Foremost among these is the fact that the staggered ar-

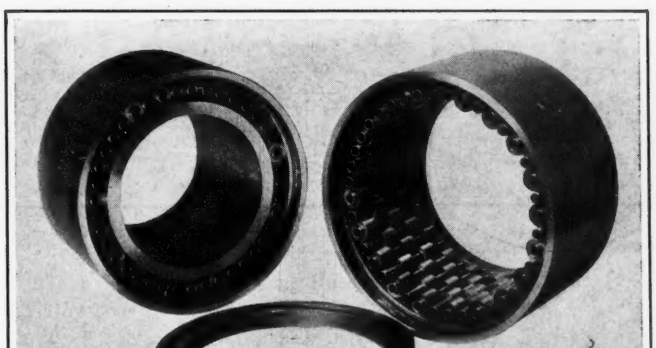


Fig. 32. Radial Roller Bearing with Staggered Rollers which reduce Angularity

rangement enables rollers of a given size to be placed in a bearing with a substantial reduction of the bearing angle, that is, the included angle between radial lines drawn from the axis of the bearing through the centers of adjacent rollers. This, in turn, relieves the bearing of a large part of the strain to which it would otherwise be subjected. By having the rollers staggered, spaces are also provided for oil or grease to circulate freely between them and assure their efficient lubrication. No cage is needed in this type of roller bearing, because the staggered rollers are all freely mounted on pins that are supported at each end by retaining rings. As a result, bearings of this type may be arranged for operation in either a horizontal or a vertical plane without any tendency for a braking action to occur due to frictional resistance between the cage and the rollers.

It is also claimed that the arrangement of staggered rollers used in these bearings, where each roller is composed of a series of short sections, is the means of improving efficiency and avoiding tendency for the rollers to be tilted out of alignment with the bearing, in cases where the direction in which the load is applied may vary considerably. Under such conditions, the load on the rollers of a bearing is likely to

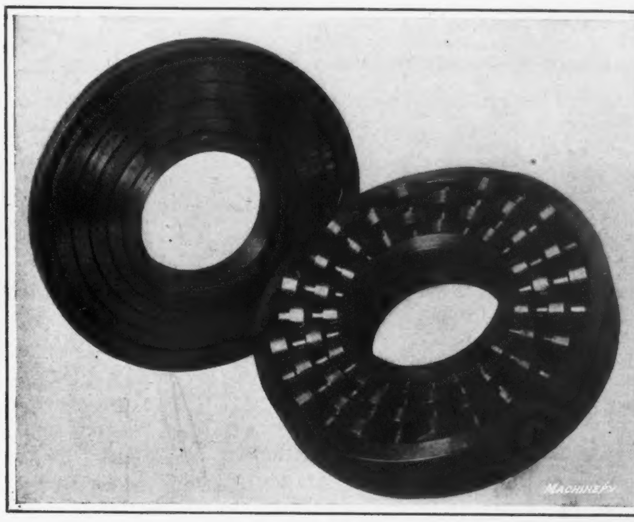


Fig. 33. Thrust Roller Bearing with Staggered Rollers of Conical Form to take Care of Variations in Peripheral Speed

become heavier at one end of the rollers than at the opposite end, with the result that the lightly loaded end tends to drag, thus tilting the roller out of line and increasing friction losses in the bearing. With the stepped or staggered rollers, the end of any roller which is lightly loaded is free to rotate independently of the heavily loaded end; that is, a differential movement occurs between individual sections of a given roller, with the result that objectionable features resulting from eccentric loading of the bearing are claimed to be largely overcome. Bearings of this type are made in designs adapted for carrying both radial and thrust loads. A radial bearing is shown in Fig. 32 and one of the thrust bearings is shown in Fig. 33. Hart roller bearings are made from one material throughout, which greatly reduces danger of damage of corrosion caused by electrolytic action when the bearings are used under water.

Lubrication of Roller Bearings

In the second installment of this series of articles, published in August, a comprehensive discussion was presented of the fundamental principles involved in the successful lubrication of ball bearings. Recommendations concerning the qualifications which make an oil or grease suitable for use in ball bearings apply equally in selecting a suitable grade of lubricant for use in roller bearings. In any form of anti-friction bearing where rolling friction exists instead of the sliding friction of a plain bearing, the function of the lubricant is to protect the bearings from rust, in addition to its lubricating action. In order for roller bearings to transmit power efficiently, it is necessary for the surfaces of both the rollers and raceways to be very accurately ground and highly polished. Any defect in the surface will soon be enlarged after the bearing is placed in service, with the result of a serious impairment of the efficiency of the bearing even if the damage does not result in complete destruction. It is owing to the necessity of protecting the bearing surfaces from all forms of damage that selection of a proper grade of lubricant becomes so important. For slow speeds and intermittent service, it has been found that a liquid grease or light machine oil is most suitable. For continuous operation and higher speeds, any good light machine oil will do.

No matter what lubricant is used great care should be taken to see that the lubricant has no corrosive effect on the surface of the bearing. Chemical neutrality is a matter of absolute importance, for if the oil or grease is either acid or alkaline, it will soon corrode the highly polished surfaces and start "pitting" which will have a disastrous effect upon the efficiency and life of the bearing. It follows as a natural corollary of this statement that the parts of roller bearings must be made of a suitable grade of steel which has been subjected to the proper heat-treatment to give physical properties of hardness and toughness that are adequate to withstand the severe stresses to which bearing members of this type are subjected under average conditions of service.

Designing Bearing Mountings to Save Trouble in Oiling

One of the important benefits resulting from the application of roller bearings in machine shop equipment—and this is entirely aside from the improvement in transmission efficiency obtained through their use—is that mountings may be so designed that it is possible to pack the rollers in an amount of oil or grease which is sufficient to last for several months, without having to give the bearing further attention. To fully appreciate the advantage of such a possibility, consider the case of bearings for countershafts and lineshaft hangers. Oiling plain bearings used in such equipment either involves running a considerable risk of injury by the man engaged in this work or else it is necessary to shut down the machines while countershaft bearings are being oiled. In any case, production is interfered with because the machine operator naturally has his attention distracted from his work while the oiler is engaged over the machine he is employed to operate. A man employed to oil machinery in a plant is not only himself a non-producer, but he interferes with the production of men who are engaged in the performance of useful work. Where the equipment is furnished with roller bearings mounted in such a way that a supply of oil is furnished sufficient to last from three to six months, the replenishing of the oil can be done on Sundays or at times when all the machinery in the plant is shut down. Thus the man employed to do the work runs no risk of falling into moving parts of the machinery, and machine operators are not interfered with in the performance of their work. Last, but far from least, the danger of neglecting to oil overhead bearings, with the inevitable result of their breaking down, is considerably reduced in cases where roller bearings are used, which are mounted in boxes filled with oil or grease, and there is a large saving in the use of oil by avoiding the waste through spilling that is customary when the old-fashioned oil-can is used.

Different Types of Machine Bearing Oilers

To facilitate the lubrication of all journal bearings, suitable oilers must be provided. Some of the types in general use are shown in Fig. 34. The types shown at *A*, *B*, *C*, *E*, *F*, *G*, *H*, and *I* are used where oiling must be done frequently with an ordinary oil-can. They provide a small reservoir for the oil and exclude all dirt and dust from the bearing. These types of oilers are used for oiling loose-pulley bearings, and machine bearings in general, that require a limited amount of light oil. Type *A*, manufactured by Gits Bros. Mfg. Co., 551 Monroe St., Chicago, Ill., consists of a body *b* which screws into the tapped oil-hole, and a sleeve *a* which can be revolved in either direction about body *b*, thus bringing the opening in *a* opposite the opening in *b*. After oiling, the sleeve is turned so as to close the opening. A spring and plunger in body *b*, acting in a groove in the sleeve *a*, prevent it from jarring open. The oiler shown at *B* is made by W. M. & C. F. Tucker, Hartford, Conn. It consists of the threaded part *a* fitted with a cap *b* which is provided with a ball *c*. Ball *c* is normally forced out against the oil-hole opening by a spring *d*, thus effectively closing the oil-hole, except when the end of an oil-can is inserted in the hole for the purpose of oiling. This type is particularly adapted for use in inaccessible places, as the cap *b* can be turned

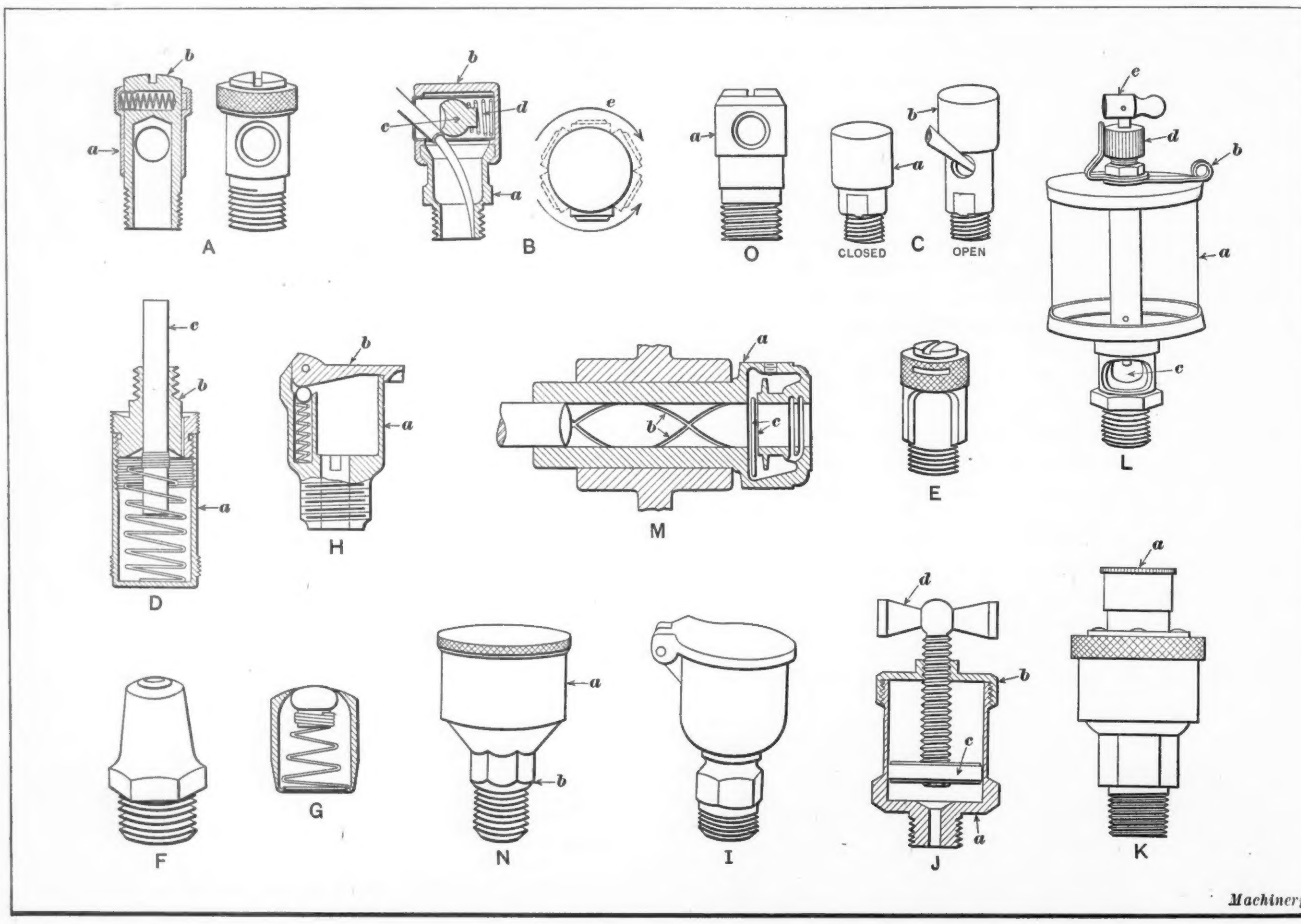


Fig. 34. Types of Commercial Oil-hole Covers, Oil-cups and Compression Grease Cups used for supplying Lubricant to Bearings. These Devices are, of course, Applicable for Use on Many Other Types in Addition to Roller Bearings

about part *a*, thus permitting oiling to be done from any position, as shown by the dotted lines at *e*.

The oiler shown at *C* is of the sliding sleeve type, and is manufactured by W. M. & C. F. Tucker. The sleeve is normally held down by a spring to cover the port, as shown at *a*, but it may be raised with the spout of an oil-can, as shown at *b*, when oiling the bearing. This oiler is said to be absolutely dustproof. Type *D* is used when oiling must be accomplished from the lower side of the bearing and is principally used on fan motors and igniters. It consists of an oil reservoir *a* which is threaded to part *b*. Oil is automatically fed to the bearing through the wick *c* when the shaft is in motion. This oiler is made by the Gits Bros. Mfg. Co. Type *E* is similar to type *A*, and is manufactured by the Bowen Products Corporation, Detroit, Mich. The oilers shown at *F* and *G* are of the spring and ball type, wherein a spring forces a ball into the oil-hole opening, thus closing the opening, except when depressed by the end of an oil-can. These oilers are made by W. M. & C. F. Tucker. Type *G* is shown with smooth sides instead of a threaded body and can be driven into place, thus eliminating the necessity of tapping.

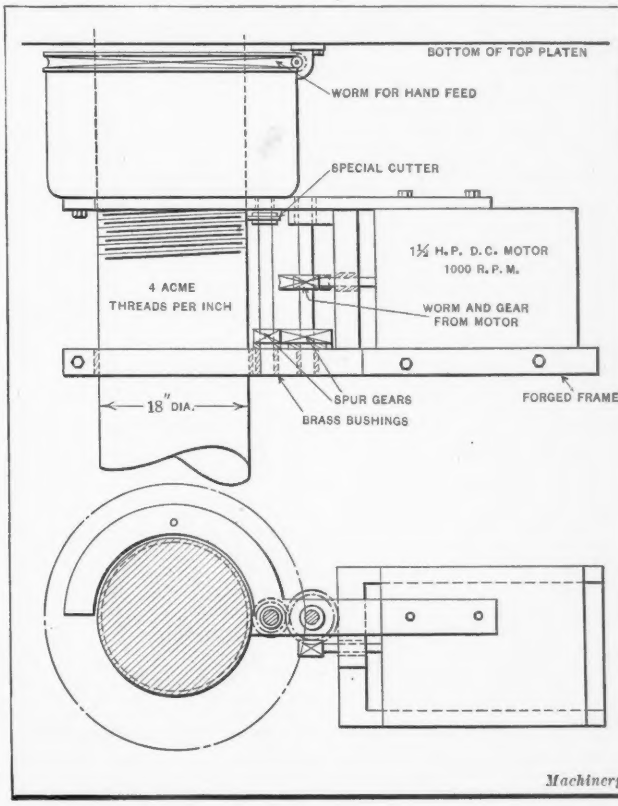
At *O* there is shown a two-piece oiler which has a sleeve *a* that is a friction fit on the stem, around which it can be turned to expose the oil port. Beeswax and tallow are used in assembling, making this oiler absolutely oil-tight, so that it is especially adapted for lubricating loose pulleys, etc. The type *O* oiler is also a product of W. M. & C. F. Tucker. Some of the other types already described can be furnished with plain, instead of threaded, ends when it is desired to drive them into place. The oiler shown at *H* is manufactured by the Wahlstrom Tool Co., 5520 Second Avenue, Brooklyn, N. Y. The reservoir or body *a* is fitted with a hinged cap *b* which is held either in the open or closed position by a ball which is pressed against the hinged part of the cover by a compression spring as shown. Another type of oiler, equipped with a hinged cover and manufactured by Gits Bros. Mfg. Co., is shown at *I*. This cover is held in the closed position by a coil spring incorporated in the hinge.

The grease cups shown at *N*, *J*, and *K* are for use where a light or heavy grease is employed to lubricate the bearing. In the illustration shown at *N*, the cap *a* serves as the grease reservoir and can be screwed down over the part *b*, thus forcing the grease to the bearing surface. This cup is made by the Bowen Products Corporation, 866 W. Warren Ave., Detroit, Mich. The type *J* consists of a body *a* fitted with a cap *b* and plunger *c*. To fill the cup, remove cap *b*, first raising the plunger to the top of the cap by means of T-handle *d*. The grease cup shown at *K* is of the spring compression type. To start the feed, the locking cap *a* is pressed down and turned to the right, and it is simply turned to the right to obtain compression. In some cases where bearings require a comparatively large quantity of light oil, the type of oiler shown at *L* is used. This oiler, which is made by the Michigan Lubricator Co., Detroit, Mich., consists of a glass reservoir *a* which permits the amount of oil contained to be seen at all times. It can be filled with an oil-can through an opening that is normally covered by slide *b*. The amount of oil being used can be seen through the sight-feed opening at *c* and can be adjusted by knurled nut *d*. The lever *e* provides a means of stopping or starting the oil feed. At *M* is shown a ring oiling device manufactured by Brown Engineering Co., 133 N. Third St., Reading, Pa., that eliminates the necessity of frequently oiling loose pulleys, by providing a reservoir for the oil and a means whereby the oil is caused to circulate through the oil-grooves. It consists of a bushing and reservoir combined as shown. The bushing has two oil-grooves as shown at *b* which, being cut in the form of two opposite-hand spirals, serve to automatically feed the oil through one groove and return it to the reservoir through the other. The amount of oil fed through the grooves increases as the speed of the pulley increases so that just sufficient oil is kept in circulation to oil the bearing efficiently.

MILLING THREADS ON COLUMNS OF HYDRAULIC PRESS

In the accompanying illustration is shown a device that the writer used for milling threads on the columns of a large hydraulic press. The stroke of the press was about 24 inches longer than that required, so it was necessary to extend the threaded part of each column 21 inches. As the columns were 18 inches in diameter, 28 feet 6 inches long, and weighed about 12 tons each, it would have been expensive to remove them from the press in order to cut the thread on a lathe. Besides, the press could not be spared long enough for this to be done; so the thread was cut with the columns in place.

The device was constructed with gears and other materials that may be found in almost any large shop. When completed, it was fastened to the bottom of the column nut, which was used to feed the device downward like the nut on a lathe apron. The nut was turned by a worm-gear, which was fastened to it by four countersunk screws. The



Device for milling Threads on Columns while in Place in Hydraulic Press

worm driving this gear was held in a bracket fastened to the top platen of the press, but could be worked down as required. This device could have been motor-driven, but the writer used a ratchet wrench because it was a cheap and satisfactory method. The only trouble experienced was in starting to cut the thread on the columns; while the first milling cutter was of high-speed steel, it would not stand up in cutting the Acme (four per inch) thread in the nickel-steel column, but a cutter was finally obtained that cut the thread easily. The eccentric bushing used to set the depth of the cutter is not shown. The hand-feed worm was blocked up after it had turned two revolutions. This device has also been used to cut slots in bars. E. C. D.

* * *

The effect of electrolytic pickling on the physical properties of iron and steel is dealt with in an article by J. Coulson in the *Proceedings of the American Electro-chemical Society*. Springs pickled in acid baths become very brittle. Hardened springs that have been pickled even for a few seconds in such a bath are likely to snap when subjected to strain. The electroplating of springs has a similar effect. Springs can be electrolytically pickled however without destroying their resiliency.

Fig. 1. General View in the Training Shop

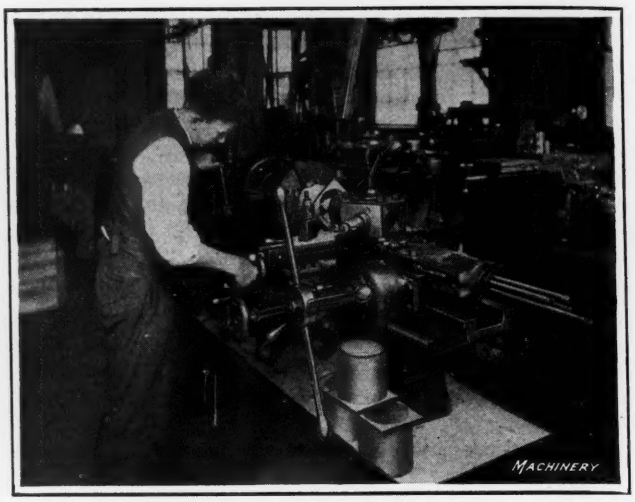


Fig. 2. A Turret Lathe Operator with a Few Weeks' Training

THE EASTMAN KODAK CO.'S TRAINING SHOP

Training departments are the order of the day. A great number of the up-to-date factories of the country have equipped themselves with some kind of training room in which inexperienced help may be quickly trained to perform machine shop work. One of the most systematic and definitely worked out ideas along this line is that presented by the training shop of the Camera Works of the Eastman Kodak Co., Rochester, N. Y. In this shop young men are made capable of performing first-class work and earning good wages in a few weeks.

IN the early part of the year the executives of the camera works of the Eastman Kodak Co., Rochester, N. Y., well-known manufacturers of photographic appliances, concluded that it would be of considerable advantage to have a training room where young men could receive definite training under a competent instructor for the work in the shops of the company. As there was no suitable space within the factories themselves, which are now overcrowded with the great amount of work being done, arrangements were made with the Rochester Mechanics Institute to open up a room where men sent by the Eastman Kodak Co. could obtain training under an instructor who also would be in the employ of the company. As a matter of fact, the training school has no direct connection with the Mechanics Institute except that it is located in the Institute building.

Class of Help being Trained

The training shop has facilities for training about eight men at a time, young men from seventeen to eighteen years old being selected. These are either boys who have previously been employed in the Eastman Kodak factories and who have been found to be bright and adapted to mechanical work, so that further training for them seems advisable, or they may be boys hired from the outside whose personality and characteristics indicate that they constitute good material for the training shop. The training is intensive, and covers anywhere from three to four weeks for the best boys, up to seven or eight weeks for those that either have less experience or need longer training. The average may be said to be about six weeks. The training is on high-class machine work of the same kind as is done in the Eastman Kodak plants. In fact, the work performed is all commercial work on parts that are used in the product of the company. Each boy is taught the operation of a single machine, as it is not the object to make him an all-round machinist, but only to train him to become an efficient operator on some particular class of work. It is evident that it is not possible in the short time allotted to train him fully in all the operations that may be performed even on one machine, but he is given a fair, all-around idea of the simpler operations that are performed on the machine. He is paid while learning at the rate of from $10 to $15 per week according to ability, and after being transferred to the shops of the Eastman Kodak Co., it is found that the boys that have been trained in the training shop are able in a short time to earn good mechanics' wages. At the same time it is interesting, from a commercial point of view, to note that the training shop is self-supporting in that the work turned out by the boys covers their pay and the overhead expense, as well as the salary of the supervisor.

The training shop was started on a small scale in order to prove its practicability, and it is likely that it will later be enlarged in order to meet the increasing demands for skilled operators in the company's plants. While the operation of only one machine, or possibly two, is taught to each boy, it has been found that when he knows the operation of one machine well, he can soon adapt himself to the operation of others, so that, when placed in the shop, if it should be necessary to have him operate other machines, there would be no great problem involved. One foreman instructor is all that is required for the supervision of the boys under training, as there is only a small number.

Fig. 3. To learn how to run a Lathe does not require a Four-year Apprenticeship

Character of Training

The boys receive instruction in the running of engine lathes, turret lathes, and milling machines, as well as in the use of drilling machines and in the grinding of their own tools. The training shop contains the following machines: No. 1 Kempsmith plain milling machine; No. 2 Kempsmith plain milling ma-

chine; 10-inch Mulliner-Enlund toolmakers' lathe; 16-inch W. P. Davis lathe; 12-inch Hendey lathe; No. 4 Warner & Swasey turret lathe; three-spindle Sigourney Tool Co.'s sensitive drilling machine; Cincinnati upright drilling machine.

In addition to being taught the operation of the machine tools and other simple machine shop work necessary around any shop, a lecture is given each day to the boys on the reading of blueprints, and there is also a talk once or twice daily on the care of machine tools. Charts are provided that show how the machines used in the shop must be oiled, indicating the location of the oil-hole. In general, the boys are given instructions in all the necessary elements required to produce a careful, conscientious, and generally well-informed operator on simple machining operations on one machine tool.

The lathe work comprises a variety of operations such as plain turning, facing, boring, threading, worm-cutting, and shoulder work. The milling includes plain milling, form milling, indexing, the use of vertical attachments, end-milling, and cam milling. The turret lathe work comprises both chucking and bar work, turning, threading, and facing. Any drilling work that is required on the parts being made is also performed by the boys.

General Conditions under which Training Shop is Run

The work is properly inspected, the same as it would be in the company's shops, by limit gages; close accuracy is required, as the work being done is of a high-class nature. The training shop is run forty-eight hours a week under regular shop conditions. It is evident that the methods employed not only guarantee a thorough training for the boys, but also give them a better conception of the use and care of machine tools than the boy that just enters the shop in a regular department could ever expect to obtain. Another valuable feature of this method of training is that the boys have an opportunity to be chosen for the work for which they are best adapted, and receive individual instruction and attention such as only an instructor having a small number of boys can possibly give them. The boys are carefully tried out as to their abilities, and if a boy does not seem to make good on lathe work, he is transferred to the milling machine, for example. This gives every boy a fair chance, and stamps the system as having been worked out with a view to fair-mindedness and with a definite aim for obtaining the best results with the labor supply at hand.

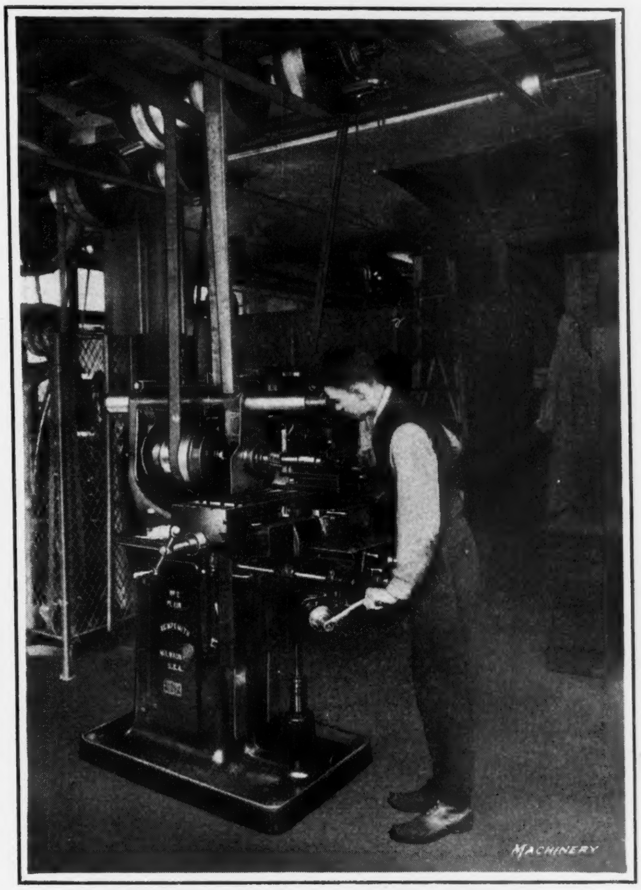


Fig. 4. Young Men, properly taught, operate Milling Machines satisfactorily after from Three to Six Weeks' Training

In addition to this training shop, the Eastman Kodak Co. maintains in its regular shop an apprenticeship in the automatic screw machine department requiring one year or eighteen months to complete, and also a tool-room apprenticeship of four years' duration. The apprentices in these courses are required to attend the Mechanics Institute during the evenings.

* * *

The nation's present production of brass is 2,910,000 pounds per day and the demand is 4,685,000 pounds. It has been estimated that with the recruiting of 9600 additional unskilled laborers the production with the present equipment could reach 3,338,000 pounds.

METHOD OF EXPRESSING TOLERANCES

BY ADOLPH LANGSNER[1]

In the September number of MACHINERY, on page 85, the question is raised whether it is advisable to adopt a new method of expressing tolerances in one's own shop or to retain the method most generally used. However, the fact is that there is no general method. Most of our leading engineering institutions do not even mention the subject of tolerances, and when Professor J. Reed, an authority on drawing and machine design, made a special investigation of the use of standard conventions and methods in making drawings, none of his questions dealt with the subject.

The simplest method is always the best one to adopt. To avoid any confusion or mistakes, guesswork or addition and subtraction should be eliminated. Where extreme accuracy is necessary, it is sufficient to write $\frac{\text{max. } 0.238''}{\text{min. } 0.236''}$ or $\frac{+0.238''}{-0.236''}$ when expressing thousandths of an inch, or $\frac{+0.2364''}{-0.2360''}$, when expressing limits in ten thousandths of an inch. The question of space when giving such dimensions should be of no consequence, it is simply a matter of arranging the dimensions with a little forethought. Proper space will be found by the trained draftsman.

Following are three general rules of a medium sized factory where a large variety of work is being done; they have been found satisfactory to all concerned:

1. All sizes where dimensions are given in inches or fractions of an inch may differ $\pm$ 0.005 inch.

2. All sizes where dimensions are given in thousandths of an inch may differ $\pm$ 0.002 inch.

3. All sizes where dimensions are given with maximum and minimum limits, as $\frac{1.2502'' \text{ max.}}{1.2500'' \text{ min.}}$, must be held within those limits.

Any new man of ordinary mechanical intelligence will quickly become acquainted with such simple rules. It has been found that even the newcomer who has not been properly instructed will produce his work within the required accuracy. It also can readily be seen that if the designer or draftsman applies the dimensions to his drawings in conformity with these three rules, the work to be done outside of the shop will suffer no delay and will come within close limits where such are required.

* * *

A contemporary calls attention to the four cardinal mistakes which often prove stumbling blocks to the advance of men whose qualifications generally would otherwise insure their progress. These are the delusion that individual advancement is made by crushing others; the tendency to worry about things that cannot be changed or corrected; the insistance that a thing is impossible because we ourselves cannot, or believe that we cannot, accomplish it; and the refusal to set aside trivial preferences in order that important things may be accomplished.

[1]Address: 2452 Racine Ave., Chicago, Ill.

USE OF VANADIUM IN STEEL-MAKING[1]

RESULTS OBTAINED BY ADDING VANADIUM TO STEEL

BY G. L. NORRIS

There is an idea that vanadium is a powerful scavenger and that the beneficial effects of its use in steel are principally due to its removal of minute, residual amounts of oxygen and nitrogen. It has even been said that when all the vanadium has been completely used up in scavenging, and none remains in the steel, all the improvement or beneficial effects possible have been accomplished. But its value as a scavenger is negligible, as there are much cheaper metals that are as effective, if not more so.

The effect of vanadium on steel is due entirely to its presence as an alloying element and its influence on the other constituents with which it is in combination. The effect of vanadium on the physical or mechanical properties of steel increases with the percentage of vanadium until 1 per cent is present, after which there is a decrease, even in the case of quenched steels, and with 3 per cent or more of vanadium the steel is actually softened on quenching until unusually high temperatures are reached, say about 1300 to 1400 degrees C. Percentages of vanadium as high as 3.5 have been successfully used in high-speed steel, and 1.5 to 2.5 per cent are not uncommon, although only a few years ago the percentage ranged from 0.3 to 0.75, and it was thought that the addition of over 1 per cent gave very little additional advantage. The improvement in high-speed steel through the use of vanadium has borne an almost direct relation to the percentage of vanadium present, and is considered to be from 60 to 100 per cent.

In the case of carbon-vanadium tool steel, the use of vanadium has proved almost equally beneficial. The steel containing vanadium has a wider quenching range, hardens deeper, retains its cutting edge longer, and is very much tougher and stronger than steel without it. A bar of 1 per cent carbon tool steel containing 0.25 per cent vanadium, quenched and drawn back at 400 degrees C., will bend 90 degrees without failure, whereas a similar steel without vanadium will bend only about 20 or possibly 30 degrees. Comparative compression tests of tool steels with and without vanadium with like tempering gave, on 1¼-inch cubes, 490,000 pounds for the vanadium steel and 278,000 pounds for the steel without vanadium. For battering tools, such as pneumatic chisels, sets, calking tools, rock drills, etc., vanadium tool steel possesses marked superiority on account of its combination of hardness, strength, and toughness.

Vanadium Steel Castings

One of the principal applications of vanadium steel has been for steel castings, particularly for locomotive frames. The composition of the steel is the same as usual for such castings, except for the addition of 0.15 per cent or more vanadium, which increases the elastic limit of the annealed castings 25 to 30 per cent without lowering the ductility. The tensile strength is not increased proportionately in the case of thoroughly annealed castings, but is usually 10 to 15 per cent greater. The following averages of tests within the same ranges of composition, having about 0.25 per cent carbon, 0.62 per cent manganese, 0.27 per cent silicon, with about 0.18 per cent vanadium in the vanadium steel, are typical:

	Carbon Steel	Vanadium Steel
Elastic limit, pounds per square inch.....	36,495	48,210
Tensile strength, pounds per square inch..	73,820	79,930
Elongation in 2 inches, per cent..........	27.3	26.6
Reduction of area, per cent..............	46.0	48.1

Vanadium-steel castings require a somewhat higher annealing temperature than ordinary steel castings, about 875 degrees C; they are also more susceptible to hardening, and therefore should be cooled slowly in the annealing furnace. Vanadium steel is much more suitable for heat-treatment than ordinary steel, as it hardens more on quenching, and consequently much higher physical properties can be obtained. Even air-cooling from the annealing temperature, followed by an annealing at a low temperature, greatly increases the elastic limit without affecting the ductility. Tests of quenched and tempered castings of the same composition show as follows, the quenching and drawback temperature being the same for both steels:

	Carbon Steel	Vanadium Steel
Elastic limit, pounds per square inch.....	58,630	72,860
Tensile strength, pounds per square inch..	90,630	95,630
Elongation in 2 inches, per cent..........	25	26
Reduction of area, per cent..............	52	56

For higher carbon steel, the advantage in favor of vanadium steel is even greater. Water was the quenching medium. There is also, doubtless, a great future for vanadium-quaternary-steel castings, both annealed and heat-treated, particularly the latter, for, as in the case of forged or rolled quaternary steels, the improvement in the mechanical properties from the presence of vanadium is much greater even than in the case of simple carbon-vanadium steel.

Vanadium Steel Forgings

The value of vanadium in simple carbon forging steels has been overshadowed by the greater mechanical properties of the vanadium-quaternary steels, such as chrome-vanadium, yet they have mechanical properties equal to those of ordinary 3 per cent nickel steel under like conditions. Except where the very high physical properties obtainable from quaternary steels are desired, carbon-vanadium steel can be used to advantage, especially for large forgings. This steel presents fewer manufacturing difficulties than quaternary steels. It is less liable to losses from shrinkage cracks and checks in the ingot, and to heating and cooling stresses in the forging and heat-treatment operations. It requires no more special care in handling than ordinary carbon steel, and is worked with equal facility.

Carbon-vanadium forging steel in the normalized condition has physical properties superior to those specified for heat-treated carbon-steel forgings. This simple treatment alone, therefore, gives physical properties sufficiently high for a great number of forgings that would otherwise have to be quenched and tempered. A large field for annealed or normalized carbon-vanadium steel is its use for locomotive forgings. It is generally conceded that there is need of a steel of greater strength, not only to meet present conditions, but also to permit of reducing sections of reciprocating parts to obtain better counterbalancing. To meet this requirement the railroads several years ago turned to heat-treated carbon and heat-treated alloy steels, notably chrome-vanadium. The use of heat-treated locomotive forgings has not proved altogether satisfactory. One objection to these forgings is the lack of heat-treating equipment in most railroad shops. Consequently, a steel that will give in an annealed condition physical properties equal to or even better than those specified for heat-treated carbon-steel forgings must prove very desirable. Carbon-vanadium forging steel responds to heat-treatment, and in this condition will meet the requirements for quenched and tempered nickel-steel forgings.

As previously stated, the influence of vanadium on the mechanical properties of quaternary steels is even greater than on simple or carbon steel. The best known and most extensively used of these is chrome-vanadium steel. Nickel-vanadium steel, while having possibly even higher tensile properties than chrome-vanadium steel, is considerably more expensive and has not been found to meet all conditions as satisfactorily as chrome-vanadium steel; it does not appear to have as high a resistance to shocks and repeated stresses. Nickel-chrome-vanadium steel has found extensive application in light armor, such as deck plate, gun shields, and armor-piercing projectiles, where its use has greatly improved the efficiency of these materials.

[1]Abstract of a paper read before the American Society for Testing Materials.

LETTERS ON PRACTICAL SUBJECTS

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FACEPLATE FOR PATTERNMAKERS' FACING LATHE

In the accompanying illustrations is shown a faceplate for patternmakers' facing lathes. By the use of two of these faceplates, one 78 inches in diameter and the other 108 inches, it was possible to handle patterns of large diameter in a very satisfactory manner. The construction of these faceplates will be readily understood from the illustrations. The central hub is 12 inches in diameter, with a web 1½ inch thick, and is finished all over. The cost of machining this hub is small as compared with the cost of machining one cast with the arms as an integral part. Furthermore, it is not as expensive a casting to make, as there is less pattern work required; and it has the additional advantage that one broken part can be replaced without having to discard a larger part.

Eight 3/4-inch holes were drilled in the flange on the face and the same number of 5/8-inch holes in the flange on the back; through these were placed the cap-screws that fasten the arms to the hub. The nuts for these screws were placed in a pocket in the arms as shown in Fig. 2. The arms had, along each side, a chipping strip that was narrow enough to be filed to a fit against the central hub. These arms were aligned with a straightedge against the turned edges of the central hub and were then weighed and paired as nearly as possible for weight, the heavy one of the pair being ground to the weight of the lighter one. It was necessary that each pair of arms weigh the same. The lightest pair were bolted to the hub opposite each other, the heaviest pair were bolted at right angles to this pair, and the two medium-weight pairs were placed in the same manner between the first two pairs. In this way a good balance was obtained, so that no vibration was felt in running.

After the arms were bolted to the hub, the assembled spider was placed on the lathe and tested at the ends of the arms; two of the arms required some additional fitting, as they varied about 1/16 inch from the others. The wooden ring was built on the floor of 2½-inch material, and the cleats were screwed over the joints as well as glued, after which the spider was taken from the lathe and bolted to this ring; in one or two places a slight shim was needed under the arms. The entire faceplate was then placed on the lathe and the wooden rim turned. This makes a serviceable faceplate that is stiff enough for any job. The cost of $60 is more than is usually spent on a faceplate of this kind, but it pays in the time saved in doing work, and in the additional safety that the design provides.

Denver, Colo. J. L. GARD

Fig. 1. Front View of Faceplate for Patternmakers' Lathe

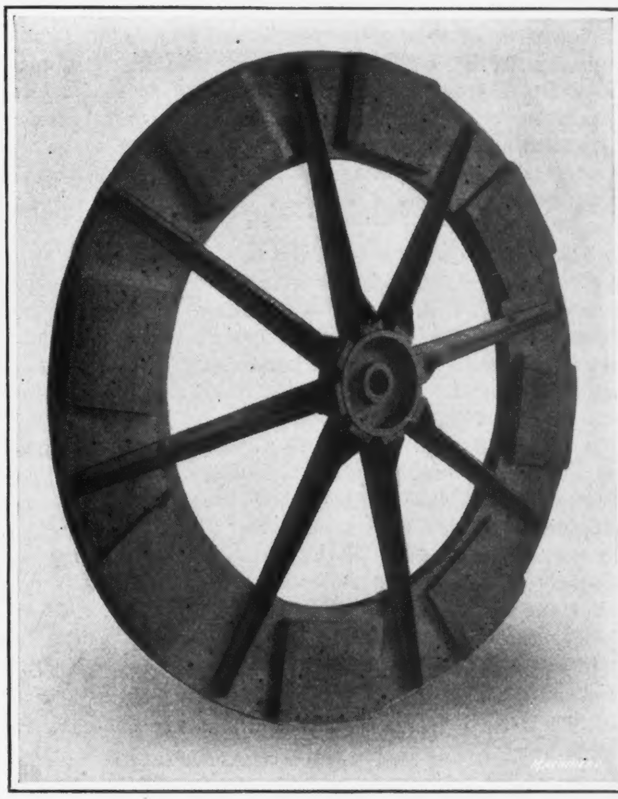


Fig. 2. Back View of Faceplate for Patternmakers' Lathe

AN INTERESTING DRILL JIG

In Fig. 1 is shown a combination flywheel and driving pinion *A* which is to be drilled and tapped for four hollow-point set-screws as shown. All the surfaces marked with dotted lines, as well as the bore, are finished when the wheel comes to the drilling machine. The problem was to construct a jig by which any unskilled laborer or boy could drill and tap these wheels quickly and correctly without any previous laying out of the holes. The jig had to be constructed so that it would be practically impossible to make any mistake in drilling when the work was properly clamped. The jig shown in Fig. 2 fulfills all these conditions and gives very good results.

It consists of a cast-iron angle-plate base *B*, which is fastened upon the drilling machine table. A bracket *C* is fastened to this base by countersunk fillister-head screws. This bracket which is of U-shape, is provided with a stud *L* fitting into the finished bore of wheel *A*. The two arms of the U-shaped bracket serve as supports for the drill guides *M*. At one side the pin *P* passes through bracket *C*, while the opposite side of *C* is provided with an indentation to receive

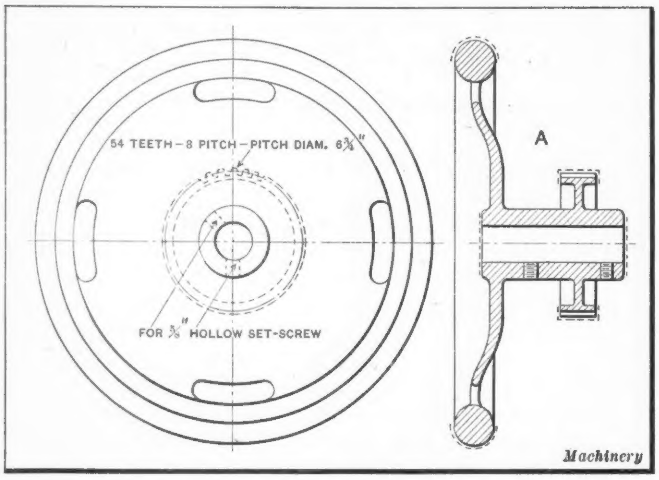


Fig. 1. Combination Flywheel and Driving Pinion

the pin *N* which connects the drill guides *M*. Pin *N* is held in place by headless set-screws *S* which also hold the drill guides to pin *P* as shown. One end of pin *N* forms a handle by means of which the guides may be conveniently swung out about pin *P* as a fulcrum. Bracket *C* fits tightly between drill guides *M* at both ends, thus holding them firmly in place. A screw *O* having its center located somewhat above the center of pin *N* prevents this pin and also the drill guides from coming up with the drill, and breaking the latter. Bracket *C* is provided with a slot in which slides a rack *D*, a detail view of which is shown at *Y*, which is provided with teeth of the same pitch as those in pinion *A* that are cut before the wheel comes to the drilling machine. The bottom of rack *D* has a narrow slot *V* cut in it extending from *F* to *G*.

A hardened stop-pin *E* is driven tightly into base *B* which protrudes into slot *V* as shown, thus determining the length of movement of rack *D* in each direction. A safety latch *H* is fastened to bracket *C*, swinging about screw *J* and resting with its tapered nose upon the taper end *T* of the low offset portion of rack *D*. Latch *H* is held in constant contact with *D* by its own weight.

To use the jig drill guides *M*, bushings *R* are swung out and the wheel is slipped upon pin *L* until the finished rim of *A* comes against the finished steel supporting plate *K*. If the operator should fail to push the wheel far enough, it will be impossible to close the drill guides *M*, as the slot between the guides that fits over the pinion will only pass over it when the wheel is in the proper place. Thus the correct location of the holes is assured. The guides are closed and the first two holes drilled and tapped. A quick-acting chuck is used to hold the drill and tap. The wheel

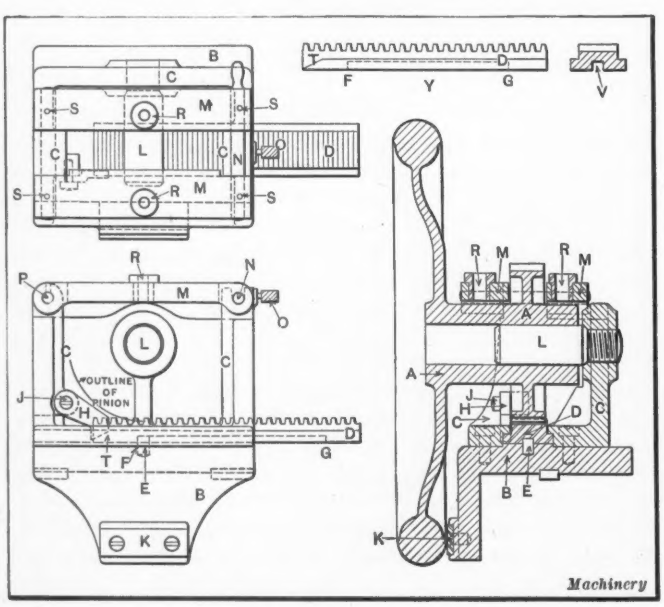


Fig. 2. Jig for drilling Set-screw Holes in Work shown in Fig. 1

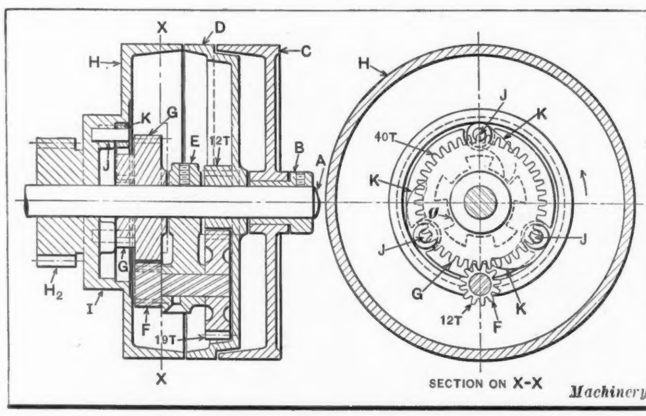
is now revolved, causing the rack, the teeth of which mesh with those of the pinion, to move until the stop-pin *E* terminates its motion at point *G*. The wheel will then have turned 135 degrees and is ready for the drilling and tapping of the other two holes. After these are finished, the wheel is turned back until stop-pin *E* comes against point *F*. The operator cannot take the wheel off nor put it on until the rack is in the correct starting position, because safety latch *H* will be lifted by rack *D*, thus preventing the pinion which just passes it when in the lowest position, from being taken off or put on. The operator must, therefore, start at the proper point for turning the full 135 degrees, and cannot make the mistake of not turning the wheel back far enough to achieve that result.

West Reading, Pa. C. F. MEYER

SLOW STARTING MOTION MECHANISM

The slow starting motion attachment shown in the illustration is applied to textile machines that are used for winding the warp threads onto a loom beam. As a precaution against breakage of the threads, caused by sudden starting, a slow starting motion mechanism is used on the machine which may be of general interest.

Shaft *A*, which is a short auxiliary shaft on which the pulleys and other parts are carried, is mounted in a bearing



Slow Starting Motion Mechanism of Textile Machine

which is bolted to the frame of the machine. Bushing *B* is fastened by a set-screw to *A* and forms the bearing for the loose pulley *C*. The slow-motion pulley *D*, which has a twelve-tooth gear cast on its inside hub, turns freely on the shaft *A*. The casting *E*, which is also fastened by a set-screw to *A* carries the steel pinion *F*, the shank of which revolves in a bearing at the end of the casting. This pinion has twelve teeth and on the opposite end of the shaft a gear of nineteen teeth is assembled, which meshes with the twelve-tooth gear on the slow-motion pulley *D*. The forty-tooth clutch gear *G* meshes with *F* and is loose on shaft *A*. This gear has a five-tooth clutch, as shown in the right-hand view at *g*. The driving pulley *H* is also loose on *A* and has a brake pulley *I* and a driving gear H_2 cast integral with it, the gear H_2 driving the main gear of the machine. On the inside of pulley *H* are three short studs *J*, each of which carries a small pawl *K*.

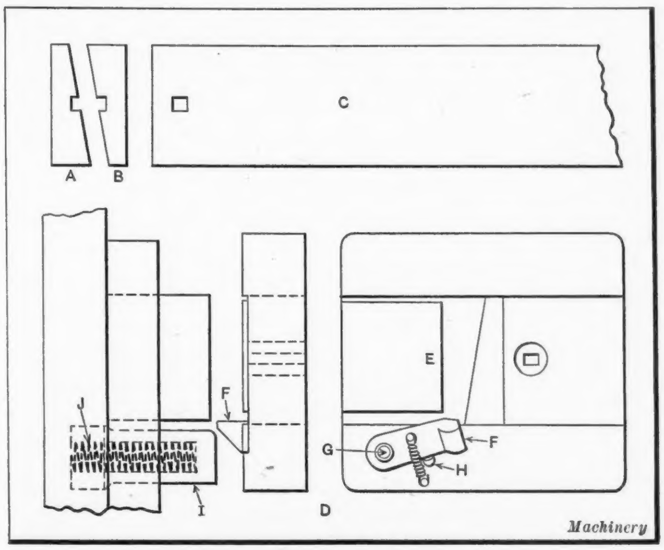
The belt-shifting mechanism is not shown in the illustration, but it is operated by a foot-treadle, which is fastened to the treadle shaft. On the end of the treadle shaft, just inside the frame, is a segment arm, which meshes with the teeth on one end of a double gear. The teeth on the opposite end of this gear operate a sliding rack which projects from the frame, just above the pulleys. The belt guide is bolted to this rack, and as the rack is run outward and the belt shifted to pulley *C*, the brake, which is also attached to the treadle shaft, is brought into contact with *I* and the machine is quickly stopped. This prevents the ends of yarn that are being wound on the beam from becoming slack or entangled, which would be a troublesome and awkward condition.

When the belt is shifted from C to D, the number of revolutions per minute of gear G is reduced to about one-fifth that of pulley D as is shown in the ratio of the teeth $\frac{12\times12}{19\times40}$, or approximately 1/5. The relation of the three pawls K to the five teeth on the clutch g is such that one pawl is always down; that is, one will always drop into the position occupied by the upper pawl, as shown in the right-hand view of the illustration. The pawl being thus engaged, the engaging tooth of the clutch, which is revolving counter-clockwise and at reduced speed, pushes against the pawl, driving pulley H, and incidentally gear H_2, slowly in the direction shown by the arrow. When the belt is shifted onto pulley H, which is also a loose pulley, gear H_2 will assume the full speed, pawls K will simply drag over the teeth in the clutch, and pulley D will become idle, as a result of the disengagement of the pawls and clutch.

F. R. Daniels

AIR-RIFLE WEDGE DIE

In the accompanying illustration at A and B are shown two blanks for a wedge used in an air rifle. The end of the strip from which they are made is shown at C; the two-stage follow die which is used to make them (two at a time) is shown at D. The metal strip C is as wide as the blank is long; therefore, there is no scrap between the blanks, and the only waste is at the ends of the strip C. The die proper is wider than the strip, so that when the blank is pushed through, it leaves the strip cut entirely off. The stop E is set beyond the die far enough to leave the blank A on top of the die. The square hole pierced in the first stage then comes over the diagonal edge of the die, so that it is cut in half, leaving a notch on the diagonal side of each piece, as shown in the illustration.



Die used in making Wedge for Air Rifle

The work is done on an inclined press, but gravity cannot be depended upon to clear the die of the thin pieces when the press is operated at high speed. A spring knock-out F is therefore provided; this swings on the screw G and is normally kept back against the stop-pin H by a light spring. In the punch-holder is the operating punch I; this has a limited up and down movement, and is drilled out nearly to the bottom for a heavy spring J. The lower corner is faced off at the same angle as the knock-out F. The action of the punch coming down on the knock-out pushes it against the strip of metal before it is cut off. This holds it back and forces the punch I to slide up into the holder and compress the spring J. The moment the strip is cut, however, the spring forces the punch and knock-out back with a quick blow, which results in knocking the blank clear of the die instantly.

Nashville, Tenn. W. B. Greenleaf

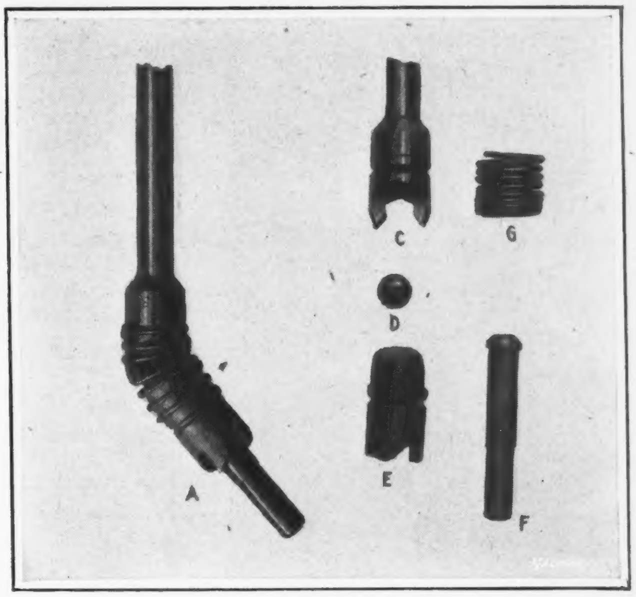


Fig. 1. Spot-facing Tool

A SPOT-FACING TOOL

At A in Fig. 1 is shown a spot-facing tool designed for use in machining a gas engine cylinder casting. The design of the casting is such that it is necessary, in machining, to reach under an overhanging water jacket; to accomplish this, the cylinder casting A is mounted on a casting B as shown in Fig. 2. A tool held in the drill chuck C and provided with a universal joint D is then used to spot-face the hole at E. Several types of universal joints were tried with unsatisfactory results before the one shown in Fig. 1 was designed and tried out. This universal joint proved entirely satisfactory, having none of the objectionable features found in the other types which were tried. With this tool the pilot can be easily started in the hole, while the tool is rotating; also the life of the joint is longer than that of an ordinary universal joint, and the part subjected to the greatest wear is so designed that it can be easily and quickly replaced by a new part.

At the right in Fig. 1 is shown the dismantled tool. The shank C which fits into the drill chuck is made from hardened tool steel, and has a yoke at the lower end. D is an ordinary steel ball, and E is a cutter, which is made with a yoke at the opposite end from the cutting edge. The pilot F is hardened and ground and slides into the central hole in cutter E. The three parts which form the universal joint are held together by the spring G. This spring also serves to keep the cutter E and pilot F in alignment with the part C when the tool is rotated at a high rate of speed.

Hammondsport, N. Y. G. C. Hannemann

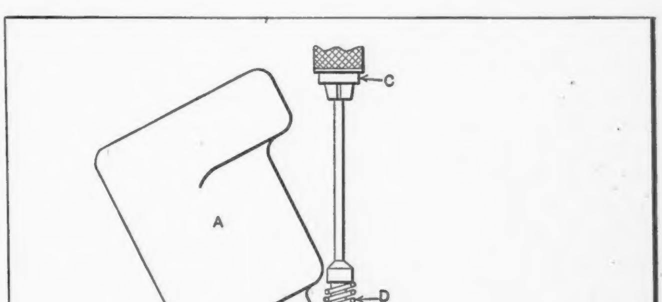


Fig. 2. Method of using Spot-facing Tool

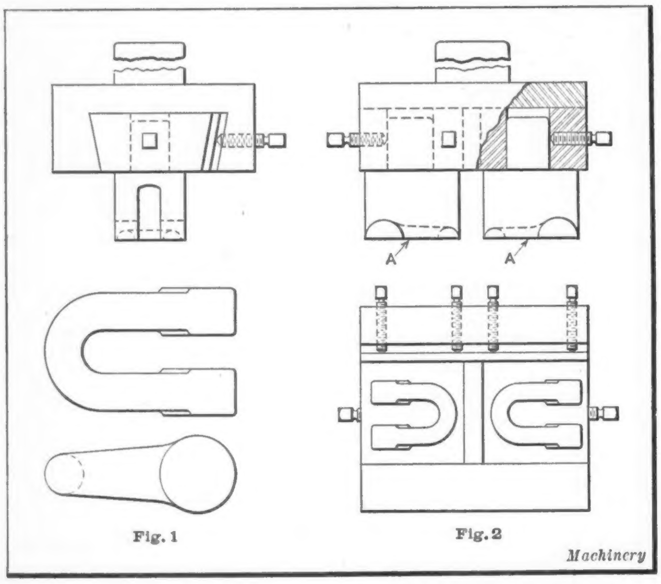


Fig. 1. Piece produced in Multiple Drop-forging Die

Fig. 2. Trimming Dies for making Two Pieces at One Time

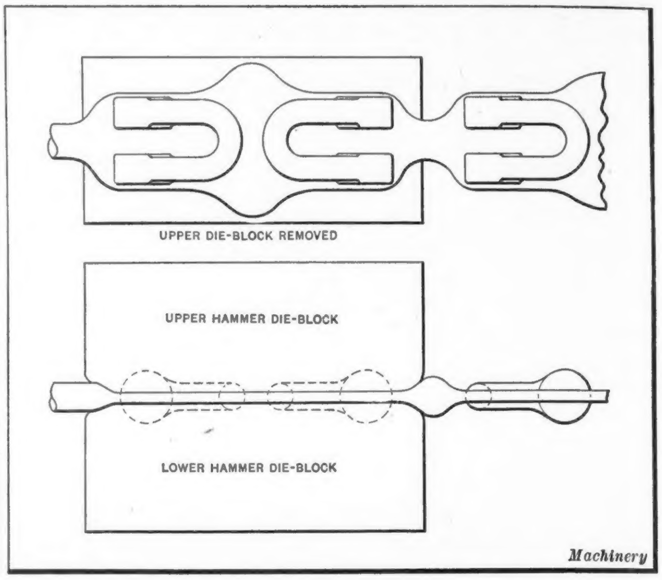


Fig. 3. Forming Dies for making Two of the Drop-forge Dies shown in Fig. 1 at One Time

TANDEM OR MULTIPLE DROP-FORGE DIES

In drop-forging and similar work, it is often possible to make two parts with the same amount of labor expended for making one. One such case is shown in Fig. 1; this piece was made from drop-forge bar steel. The hammerman heated about three feet of the bar and produced two parts at the end as shown in Fig. 3. Then the pressman, placing the pieces in the corresponding positions in the trimming dies shown in Figs. 2 and 4, stripped the two parts for each stroke of the punch press. The punches *A*, Fig. 2, are adjustable and are inserted in sub-punch-holders to accommodate the spread of the trimming die. A stripper *B*, Fig. 4, is also used. The method is applicable to similar parts and, if necessary, the center portions can be punched out.

Chicago, Ill. F. R. Zimmerman

OBSERVATIONS ON EMERY WHEELS IN SHOPS

Opinions vary greatly in regard to the usefulness of the emery wheel, if one may judge from appearances. Some shops have emery wheel stands located among their machines in every conceivable corner, with well-kept bearings, good belts and keen cutting wheels, running true and always ready for work. Other shops, equally well equipped in other respects, have so little to show in grinding machinery that the men do not form the habit of using this great time-saver. We have seen emery wheels selected by office men whose only basis for choice was lasting qualities. In their opinion, if a wheel wore out in six weeks it was worth six wheels that wore out in the same length of time. Some emery wheels grind three times as fast as other wheels having a similar appearance. Suppose we assume that an average 12-inch by 1-inch emery wheel for miscellaneous work will stand up under continuous use for 90 hours, grinding all kinds and shapes of material, and is then worn too small for the speed its spindle is running. If a keener cutting wheel is selected which would do the same 90 hours' work in 45 hours, then the keen-cutting emery wheel will have saved 45 hours of the average machinist's time during its lifetime. At a fair estimate such saving would be, say, 45 cents for the machinist's time and 25 cents for overhead expense, making 70 cents per hour for 45 hours, or a cash saving of $31.50, which is several times the cost of a wheel of that size. This goes to show that the extremely durable wheel would not be economical to use, even if accepted as a present.

Most people buy a 1½-inch to 2-inch face wheel on the same grounds that the office man selected that everlasting wheel. Of course, the wide wheels keep their shape much longer, but so does the article it works upon. In other words, it does not grind as fast as a thinner wheel, the extra width of the wheel only serving to heat the article being ground. In short, the emery wheel which does not wear itself out will not wear the work out either. The corner of any wheel will cut twice as fast as the flat face will. It is for that reason that corners of wheels are generally rounded off. If, then, the face of the wheel is wide, that expanse of flat surface between the corners only prevents access to the corners. It follows that a 2-inch face wheel is worth less in actual practice than a 1-inch face wheel. It costs more, and is worth less for grinding

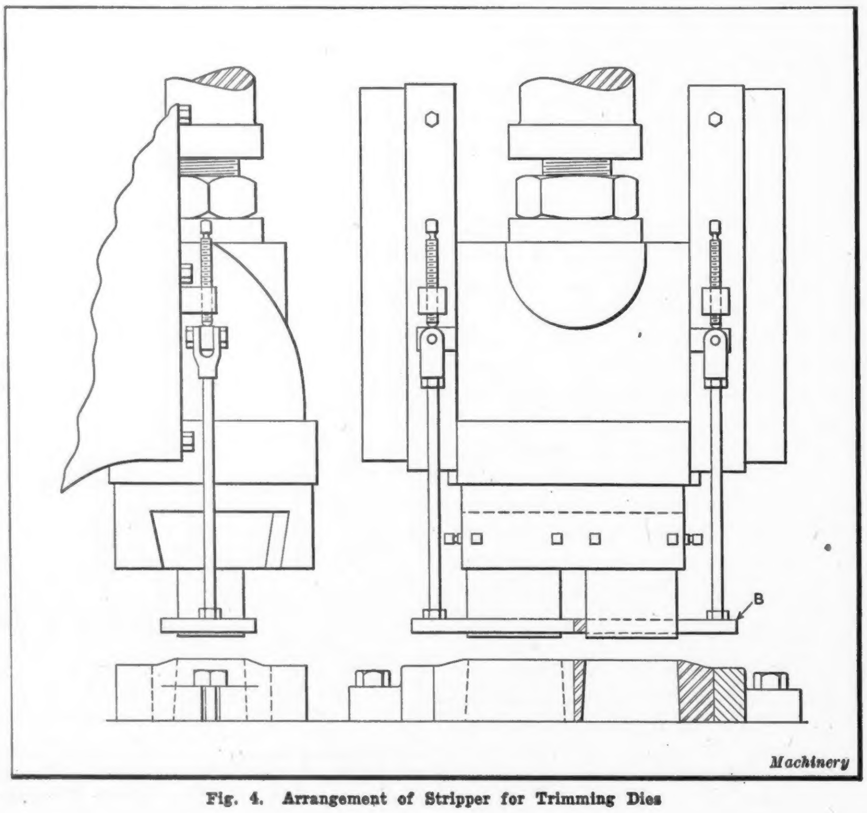


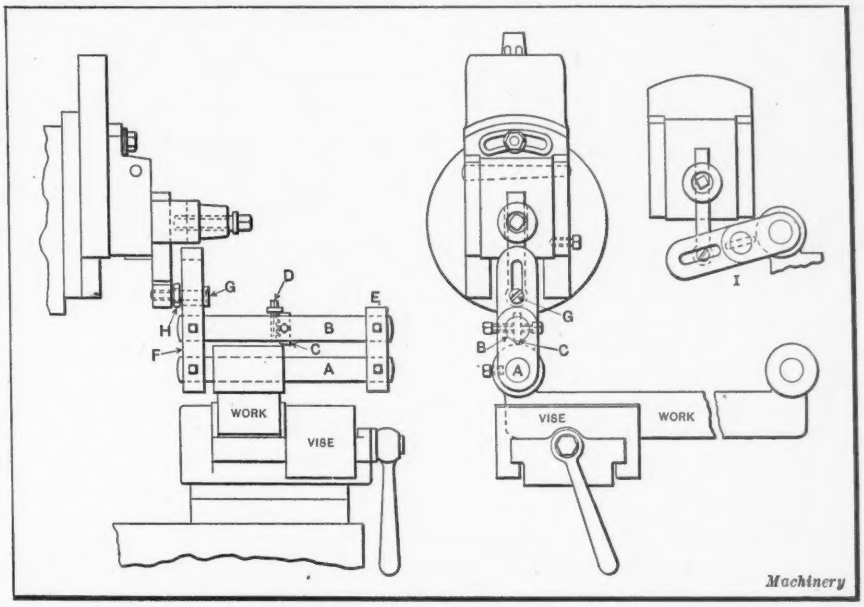
Fig. 4. Arrangement of Stripper for Trimming Dies

purposes. The machinist's time is so much greater an item than the cost of the wheel that it is a good reason why all such items as cost of wheel should be relegated to the rear and everything which can possibly conserve time should be given the right of way.

The emery wheel is so ready and rapid a servant when kept in good working order that it is surprising to find its neglect so nearly universal. The foreman often allows the men to use a grinding wheel when the driving belt is so loose as to allow the wheel to be stalled by a light pressure of work against it. The belts should be kept tight. A loose belt also requires a longer time than a reasonably tight belt would to set the wheel in motion.

Another popular fault is allowing a wheel to run out of true. It is not a debatable question whether it pays or not to keep wheels true. We all know it would pay, but yet they are not always kept true. Most wheels for general use in ordinary shops are left to the haphazard care of any or all the men, and the only truing up they receive is when some man has a job which positively requires a true wheel. He then unwillingly reduces the wheel to a condition of reasonable usefulness. Most of the time, however, the wheel is unfit for service. It is a good plan to detail the job to one man and see that he trues the wheels up every morning. The emery wheel would be a money-maker in any shop were it, in the first place, intelligently selected and then kept in trim by an operator, who, of course, must be trained to do this properly.

Los Angeles, Cal. S. B. WELCOME



Shaper Fixture for finishing Outside of Bosses

SHAPER FIXTURE FOR FINISHING OUTSIDE OF BOSSES

The accompanying illustration shows a shaper fixture which was used in finishing the bosses on a tool employed in testing ordnance work. The work was approximately three feet long and had two bosses, which had to be finished within close limits. The fixture was designed for use on a shaper, as it was found impossible to swing a piece of this length between the lathe centers.

A tool-steel bar *A* was turned to a sliding fit in the bore of the work. Another bar *B*, of 7/8 inch diameter, was provided with a 3/8- by 3/8-inch slot through the center to receive a tool-steel bit *C* held by a 1/4-inch set-screw. A 1/4-inch screw *D* with a large collar was added directly behind the tool to adjust the cut. Both bars were joined with a pair of connecting pieces of cast iron *E* and *F*, fastened with 1/2-inch set-screws. The rear connecting piece *F* was extended and provided with a 1/2-inch slot. The whole frame was driven and fed by a 1/2-inch screw *G*, tightened in a holder by means of a check-nut *H*. Being held between a check-nut and a screw-head, the fixture had 1/64 inch clearance to compensate for any slight misalignment. The cut was started on one side of the boss, and carried around, first by raising the vertical feed until the fixture stood at an angle of 45 degrees; the side feed was then engaged to carry the cut 90 degrees farther. The rest of the operation was performed by dropping the vertical feed, as shown at *I*.

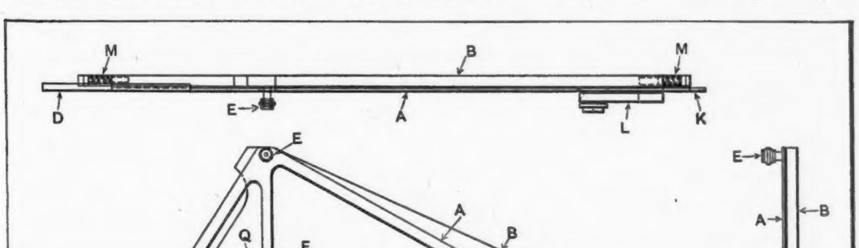
Plainfield, N. J. HENRY DAUT

SQUARE TESTING DEVICE

For a long time the experimental department of a large manufacturing establishment accepted the maker's guarantee as proof of the accuracy of its try-squares. Through usage, the accuracy of these tools often became impaired, so that with no method of determining their accuracy, the exactness of the work was always in question. This uncertainty, however, is now entirely eliminated by the device shown in the accompanying illustration.

This device consists of an oscillating beam *A* mounted on a knife-edge bearing *C* that is firmly fastened in plate *B*. A weight *D* counterbalances the projected arm of beam *A*. Hardened steel rolls *E* are ground to a uniform size, and fit snugly on pins attached to the oscillating beam *A*. The plate *B* rests on the base rail *H*. Into *B* and *H* are set hardened and ground plates *J* that form a bearing for the hardened and ground rolls *I*, which constitute a roller bearing for plate *B*. The hardened plug *K* is set into the end of beam *A*, and a guide plate *L*, fastened to the end of plate *B*, serves to guide the end of beam *A*. To avoid friction as much as possible, small round-head pins are set into beam *A*, thus giving a point bearing on plates *B* and *L*. The guide pins *M* serve to keep the plate *B* in alignment with the base rail *H* when plate *B* is in motion. The springs *N* wrapped about the pins *M* serve to equalize the pressure upon the oscillating beam *A* when it is in use. The lock *O* is moved into the position shown by the dotted lines at *P* when the device is in use. This device is intended to rest upon a true surface plate.

The operation is as follows: The square *Q* is placed against the side of base rail *H*, and in contact with the rolls *E*. Pressure is then exerted upon the square in such a manner as to cause the plate *B* to move



Device for testing Try-squares

laterally on base rail H until the edge of the square comes into contact with the stop-pin R. The beam A then conforms to whatever angle the blade of the square makes with its base. The position of the plug K is then obtained with an indicator, after which the square is moved to the opposite side of rolls E, as shown in position Q_1, and pressure is exerted until the square again makes contact with the pin R. Beam A again conforms to the angle which the blade makes with the base. If the position of plug K, as obtained with the indicator, corresponds to the previous position, the blade of the square forms a perfect right angle with its base. If the blade does not form a perfect right angle with its base, plug K will assume a different position from the position first taken, and this difference can be readily detected by means of the indicator.

This device was designed for squares from 6 to 12 inches; smaller squares are compared with the larger squares after the latter have been found to be correct by the device. In testing 12-inch or larger squares, the middle roll is slipped off its pin and the top roll is used. This device will be found in use to be very sensitive and to detect the slightest variation from a right angle.

Dayton, Ohio CLARENCE H. TAMPLIN

DOUBLE AND COMPOUND ANGLES

Practically all draftsmen and machinists are familiar with the formulas employed in solving problems in which right-angled triangles are involved, and a great many can also work out problems requiring the solution of oblique-angled triangles, but the method of solving double or compound angles is not so well known. The following, however, is a very simple method: Suppose that a 45-degree angle on elevation CAB is to be swung 30 degrees in a horizontal plane about point A. The plan view of this angle before being swung around would be a straight line DE equal to the length of the base AB. Now swing the line DE through an arc of 30 degrees to the position DF and draw a line perpendicular to line AB from the point F. Call this line FJ and lay off HJ equal to CB. Triangle HAJ is now the true elevation of the triangle in its new position DF, the side AC being represented by line AH, and side BC, by side JH. Now $AB = DE = DF$; and $BC = HJ$.

$BC = AB$ tan 45 degrees; therefore, $HJ = AB$ tan 45 degrees.

Further, $DG = DF$ cos 30 degrees; and as $DG = AJ$, $AJ = DF$ cos 30 degrees $= AB$ cos 30 degrees. Now $\tan \alpha = \frac{HJ}{AJ}$, or $\tan \alpha = \frac{AB \tan 45 \text{ degrees}}{AB \cos 30 \text{ degrees}} = \frac{\tan 45 \text{ degrees}}{\cos 30 \text{ degrees}}$.

This principle can be carried a step further and a compound angle worked out in the same manner, resolving the problem into a series of simple motions. In using this method any convenient side of the triangle may be taken as unity and the problem solved with the trigonometric functions of the angles. If a book giving the logarithms of the trigonometric functions is available, the problems are made comparatively simple and the chances of making errors are considerably reduced.

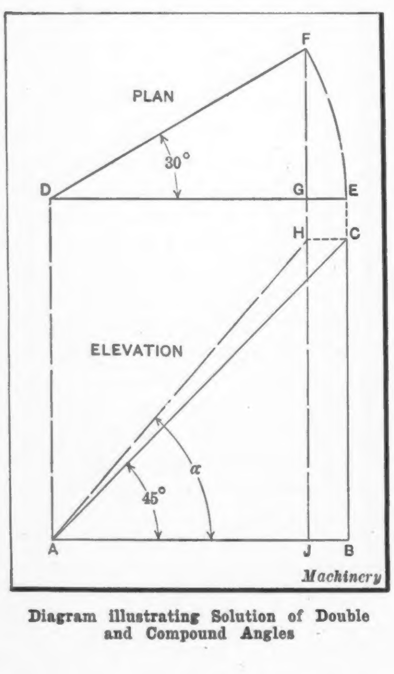


Diagram Illustrating Solution of Double and Compound Angles

Hartford, Conn. THOMAS A. REILLY

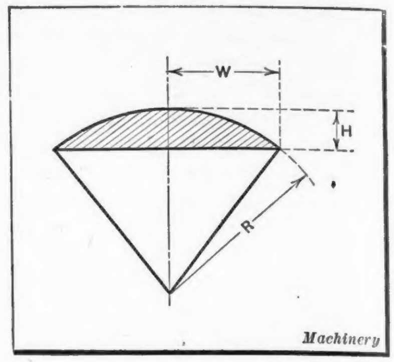
FORMULAS FOR CIRCULAR SEGMENT

Two simple formulas for calculating the length and height of circular segments are as follows:

$$H = R - \sqrt{R^2 - W^2}$$

$$W = \sqrt{R^2 - (R-D)^2}$$

where W = one-half length of chord;
R = radius of circle;
H = height of segment.



Circular Segment Diagram

While formulas for determining the same results are shown in MACHINERY'S HANDBOOK, page 132, in many cases the above formulas will be found of value. The fact that W represents but one-half the length of the chord simplifies the formulas greatly, but this fact should be borne in mind when using the formulas.

Milford, Conn. D. S. HULL

METHOD OF EXPRESSING TOLERANCES

There are at least three methods of expressing tolerances in general use. Among the older manufacturers tolerances are probably expressed thus: $1.375 \begin{smallmatrix} +0.001 \\ -0.001 \end{smallmatrix}$. A method quite generally used gives the maximum dimension in full and directly underneath the minimum dimension in full, thus: $\begin{smallmatrix} 1.376 \\ 1.374 \end{smallmatrix}$. Then there is one of the methods given on page 85 of the September number of MACHINERY, thus: 1.375 ± 0.001. The method used by several other manufacturers is similar to the first except that the tolerance is enclosed in a brace, thus: $1.375 \left\{ \begin{smallmatrix} +0.001 \\ -0.001 \end{smallmatrix} \right.$. The writer adopted this method after several serious errors had been made in the shop by the dimensions on the drawings in the old days being expressed thus: $1\frac{1}{2} + 0.003$ to indicate that the part was to be machined to 1.503 inch. The men in the shop being accustomed to reading tolerances on the greater number of drawings, thought that this decimal was a tolerance. Of course, when all drawings have been revised, or in the case of concerns using only new drawings, there would not be any advantage in the last method over the first. The writer knows, however, about other concerns having errors made by the same misinterpretation of dimensions on drawings dimensioned as stated. While possibly the first method is almost universally used, there is no disadvantage in using the last.

Taking it all together it seems that the first method, with or without a brace, should be the one most generally used. However, the question as to what dimension gages should be made should be taken into consideration. In general, when a man is working for a gage fit and does not use a limit gage, the gage should be made the maximum dimension on a bored diameter and the minimum dimension on a turned diameter, providing the limit is not too large, so as to allow a little for wear of the gage.

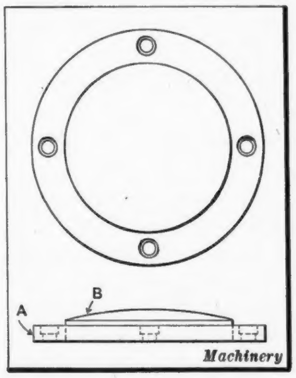
The men should be instructed that finished dimensions, when given without a tolerance, are assumed to have a certain fixed tolerance. The amount will naturally vary considerably, depending on the class of work. For instance, a firm doing tool work will use a smaller fixed tolerance than one doing general machine work. There can be no doubt but that it would be desirable for all shops to use the most generally adopted method of expressing tolerances and thereby eliminate all question as to the interpretation of dimensions when working to drawings that are made by other concerns.

Cleveland, Ohio J. F. HATTERSLEY

SHOP AND DRAFTING-ROOM KINKS

PAD FOR PROTECTING COLLETS AND MACHINES

It is customary for machine operators when putting drills into collets or removing them to rap them on the machine, no matter whether it is a boring mill, lathe, or drilling machine. In so doing, the end of the collet is likely to be damaged and the machine marred or scratched. This damage may be prevented by putting a simple lead pad on the machine in a convenient location. Then any knocking that may be necessary can be done on the pad, whether it be removing drills from collets, setting an arbor in work, tightening a dog, etc. A convenient pad, as shown in the accompanying illustration, consists of a steel ring *A* that may be held to the machine by screws, in the center of which lead is poured, the pad *B* being thickest at the center. The ring should be removed from the machine and put on a flat plate when the lead is to be poured into it, so that the machine members will not be distorted from the heat.

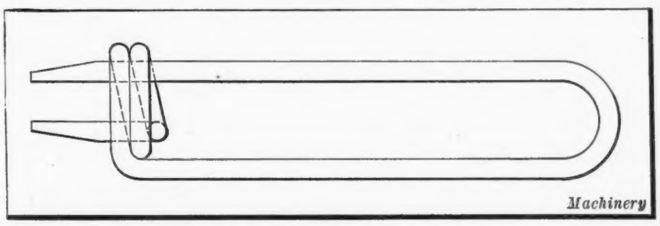


Lead Pad for protecting Collets and Machine

H. M.

SPRING TONGS THAT CANNOT SLIP

Most of the spring tongs that are used for holding small pieces of metal will slip to one side occasionally, causing much annoyance, especially if the workman is drawing the temper in a piece of steel. The tongs here shown are made of round steel, which is wound two turns from the heel of one jaw over the jaw opposite, forming an oblong slot which holds the jaws in alignment.

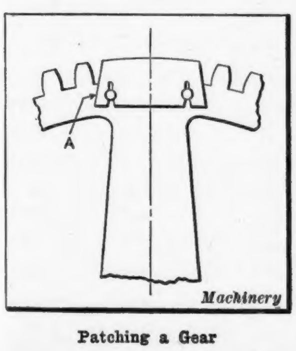


Spring Tongs that cannot slip

New York City E. J. HIGGINS

METHOD OF HOLDING PATCH IN GEAR

It is often necessary to patch a gear. A satisfactory method for holding the patch in place is shown in the illustration. A dovetail recess is first machined and the patch set in at the desired place, as shown at *A*. Two holes are then drilled through the patch and slots cut through the holes. Taper pins driven into the holes will force the slots open and lock the patch in place. To the writer's knowledge, no trouble from patches falling out has ever been experienced with this method.

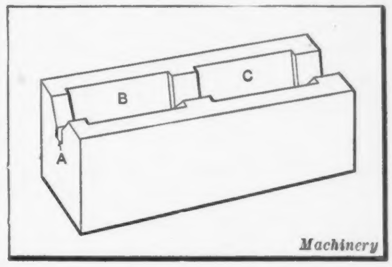


Patching a Gear

FRED FRUHNER
Milwaukee, Wis.

USEFUL ADDITION TO TOOL CRIB

A useful addition to the tool crib for distribution is a quantity of V-blocks like the one shown in the accompanying illustration. Ordinarily, V-blocks are made solid and have a slot milled through the center as at *A*. The V-block shown is machined from a casting, the sections *B* and *C* permitting a drill of larger diameter than the width of the slot *A* to pass through the work in the drilling process without the marring and cutting away that is usual with the ordinary type when the drill is cutting through. The V-blocks may be made in sizes corresponding to the various requirements.

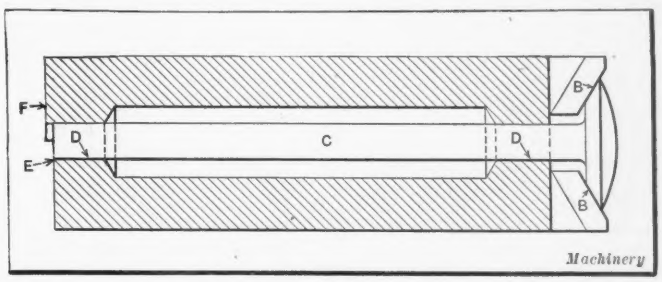


Improved V-block

East Rutherford, N. J. GEORGE F. KUHNE

HANDY GASOLINE ENGINE VALVE GAGE

In the accompanying illustration is shown a most convenient gage for gasoline engine valves of the mushroom type, which is the type most used. With this gage the bevel seat is tested at *B*, the diameter of the valve stem *C* at *D*, and the length of the stem at *E* for minimum and at *F* for maximum length.

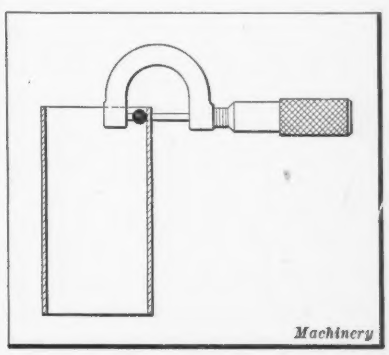


Handy Gage for Gasoline Engine Valves

Detroit, Mich. C. C. SPREEN

MEASURING THICKNESS OF PIPE AND TUBING

The accompanying illustration shows a simple and accurate method of measuring the thickness of pipe and tubing. A common micrometer is used in connection with a steel ball to obtain a point contact on the inside of the tubing; the true thickness of the tubing is the micrometer reading less the diameter of the ball.



Method of measuring Thickness of Pipe and Tubing

HOWARD M. NICHOLS
Readville, Mass.

* * *

According to a statement by Acting Secretary of War Crowell, 5000 motor trucks were shipped to France in the "knocked down" condition during September.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DIE FOR FORMING THIMBLE

F. M. H.—On page 71 of the September number of MACHINERY was illustrated a thimble to be formed by a die. Readers of MACHINERY were requested to suggest methods by which this work could be done. In this connection it should be stated that the Crogan Mfg. Co., Bangor, Me., has made dies that will cut off stock and form a thimble complete in one operation of the press with an output of from 50,000 to 60,000 per day.

DIE FOR FORMING THIMBLE

Answered by Donald A. Baker, New York City

The writer agrees with the statement made on page 71 of the September number of MACHINERY, in the article entitled

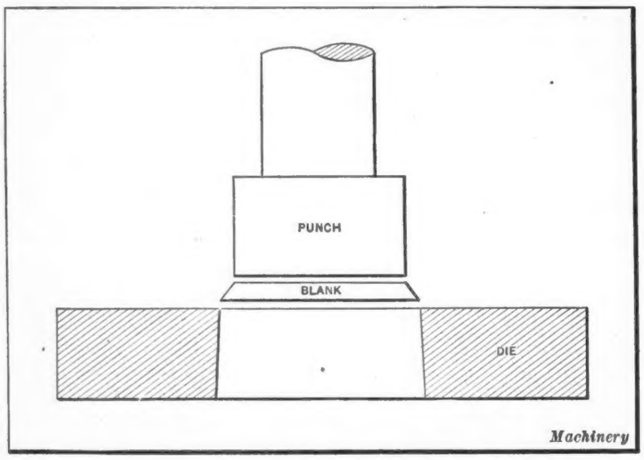


Fig. 1. Punching Blank with Beveled Edges

"Die for Forming Thimble," that it would be impossible to form this thimble without leaving the opening shown unless the ends were beveled. However, with stock as heavy as that of which the thimble is made the edges of the thimble may be beveled if the punch is made as much smaller than the die as is possible without leaving a burr on the blank, as shown in Fig. 1. One side of the blank is always the size of the die through which it is punched and the other is approximately the size of the face of the punch. It is a question, however, whether or not this plan will give sufficient bevel for the purpose.

It would also seem that if the second blow struck by the punch were sufficient to close the joint tightly, the punch

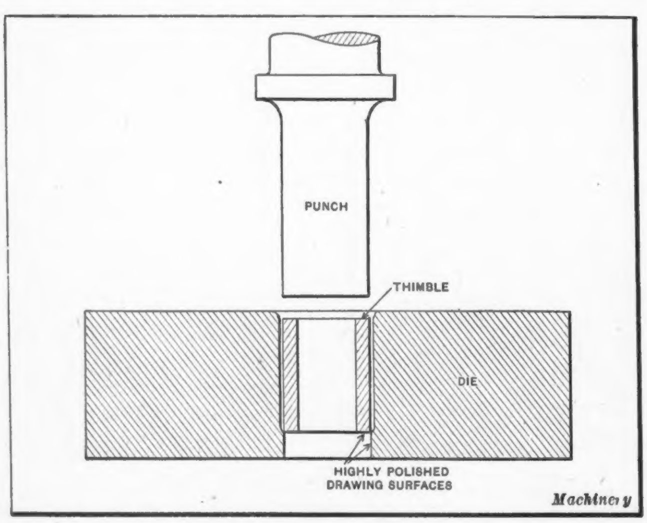


Fig. 2. Die for finishing Thimble

would leave a mark on the outside of the thimble, especially as it does not cover half the surface of the work. In this case a smooth finish may be obtained by passing the thimble through a die similar to that shown in Fig. 2. This die is simply a drawing die, and it should be made small enough so as to reduce the outside diameter of the thimble a few thousandths inch. The method described in the foregoing will be found to produce a smooth thimble that is accurate in size.

FINDING ANGLES OF SPECIAL SCREW THREAD

Answered by Walter H. Webster, Cincinnati, Ohio

There is a much simpler method of finding the angles of a special screw thread than that given on page 1043 of the July number of MACHINERY. As before, for convenience in handling and to lessen the liability of error, the dimensions are reduced to the common fractions 1/20 inch, 1/4 inch, 3/16 inch, and 5/16 inch, and then multiplied by 160 and the products 8, 40, 30, and 50 used. Then $CD = 2r = 16$, $AC = 50$, $AB = 40 - 2r = 40 - 16 = 24$, $CB = \sqrt{AC^2 + AB^2} = \sqrt{50^2 + 24^2} = 55.46$. As $\tan\alpha = \frac{50}{24} = 2.08333$, $\alpha = 64$ degrees 21 minutes 32 seconds. As $\sin\beta = \frac{16}{55.46} = 0.28849$, $\beta = 16$ degrees 46 minutes 4 seconds. Therefore $\delta = 64$ degrees 21

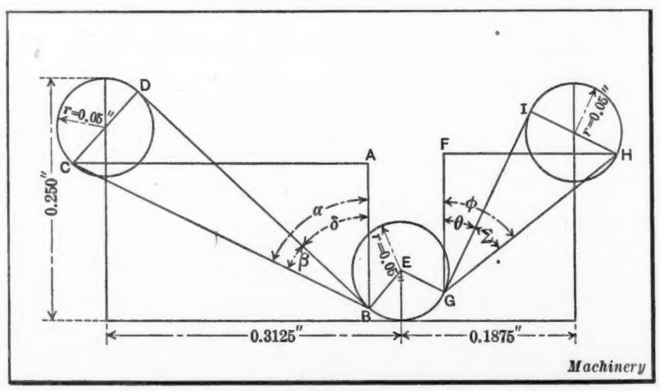


Diagram for finding Angles of Special Screw Thread

minutes 32 seconds — 16 degrees 46 minutes 4 seconds = 47 degrees 35 minutes 28 seconds.

Distance $FH = 30$, $FG = 40 - 2r = 40 - 16 = 24$, $IH = 2r = 16$, $GH = \sqrt{FH^2 + FG^2} = \sqrt{30^2 + 24^2} = 38.418$. As $\tan\phi = \frac{30}{24} = 1.25$, $\phi = 51$ degrees 20 minutes 25 seconds. As $\sin\Sigma = \frac{16}{38.418} = 0.41647$, $\Sigma = 24$ degrees 36 minutes 43 seconds. Therefore, $\theta = 51$ degrees 20 minutes 25 seconds — 24 degrees 36 minutes 43 seconds = 26 degrees 43 minutes 42 seconds.

* * *

WELDED JOINTS VS. SCREWED FITTINGS

Tests made at the University of Kansas, according to the *Acetylene Journal*, show that welded joints are superior to screwed fittings. In all cases the joints were tested under internal hydrostatic pressure to the point of failure. Throughout the test, no welded joint broke and only one joint leaked, and that only when it was subjected to a pressure of 3850 pounds per square inch. The bursting pressures of the screwed fittings, which were malleable iron tees and couplings, were much lower, and invariably the failure was in the fitting itself.

AUTOMATIC SHELL MARKING MACHINE

A fully automatic marking machine for stamping the lot number and manufacturer's initials, or other identification marks, on shells has recently been developed by A. H. Williams, superintendent of the American Shell Co.'s plant of Paterson, N. J., and is now in successful operation at the company's shop. This concern is manufacturing approximately 13,000 U. S. 75-millimeter shells per three-shift working day, and formerly required four operators working constantly to perform the stamping operation. The marking machine is at present speeded to forty shells per minute, and it is the opinion of Mr. Williams that it will be possible, by increasing the speed, to mark sixty shells per minute. At the present rate the entire daily output of the factory can be stamped in less than six hours, requiring but one operator. The machine weighs approximately 600 pounds.

Two views of the machine are shown in Figs. 1 and 2. As the shells leave the final machine inspection they are fed to the stamping machine by means of the gravity conveyor. The number of shells required in the conveyor to advance the shells to the desired position may be regulated by adjusting the two roll brackets *E*, Fig. 1, one of which is located on each side of the machine. The pressure required on the shells by the wooden rolls which are carried in these brackets is slight. The first shell advances until it comes between these rolls; the trigger catches the bottom of the shell and, on the forward stroke, deposits it in the saddle formed by the cradle rolls *J*, with the nose of the shell against the stop *N*. There are two sets of these rolls, front and back, mounted in bearings in the casting *I*, which are capable of revolving. As soon as the shell has been deposited, as shown in the illustration, the stamp-holder casting *B* comes into contact with the shell and the die, which is set into the end of the holder, makes its impression just above the copper band, causing the shell to roll in the cradle. The shell ejector *C* is fastened to the stamp-holder and immediately following the stamping operation, ejects the shell.

The auxiliary shaft *A*, which carries the stamp-holder casting *B* is driven through a large spur gear and pinion as shown. The short shaft, through which motion is transmitted to the miter gears *F*, is driven from shaft *A* by the spur gears *M*. These miter gears drive the upright shaft

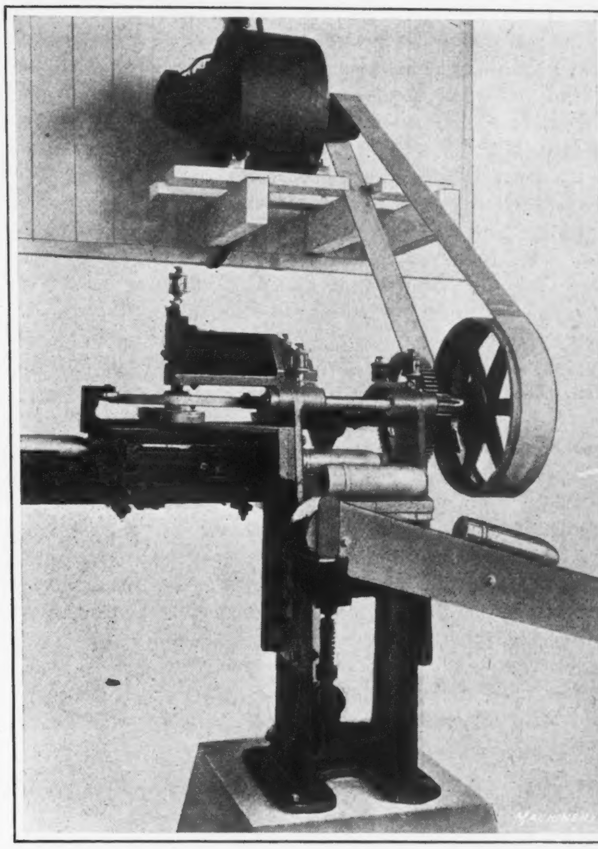


Fig. 2. Front View of Shell Marking Machine showing Motor Drive

S which carries the two-throw cam *G*. This cam controls the timing action for the working of the entire machine. Attached to the under side and near the outside edge of the cam there is a cross-slide which is mounted on a stud. This cross-slide operates in the cross-guide *D*, and, as the cam revolves a reciprocating motion is produced and transmitted to the trigger holder which rides in the longitudinal guide *H*, and which is attached to the cross-guide. The trigger holder, as the name implies, carries at its foremost end the shell pusher or trigger. The trigger is hung in the clevised end of the holder and is continually reciprocating, being timed with each revolution of the stamp-holder casting on shaft *A*. The cam rollers ride on the periphery of the cam, one being mounted in each of the steel forged brake levers *L* and *K*, causing these pieces to swing on their respective fulcrum points, which are on opposite sides of the machine. The ends of the brake levers are constantly under spring tension so that as the periphery of the cam rises and falls the brakes also rise and fall, acting somewhat like an escapement movement. The lower or brake part of the lever *L* is shown at *e* and the lower part of the lever *K*, which is U-shaped, extends under the conveyor and up on the opposite side. The lugs or projections which form the brake on this forging extend in toward the shell from the upright parts of the U-shaped end of the lever.

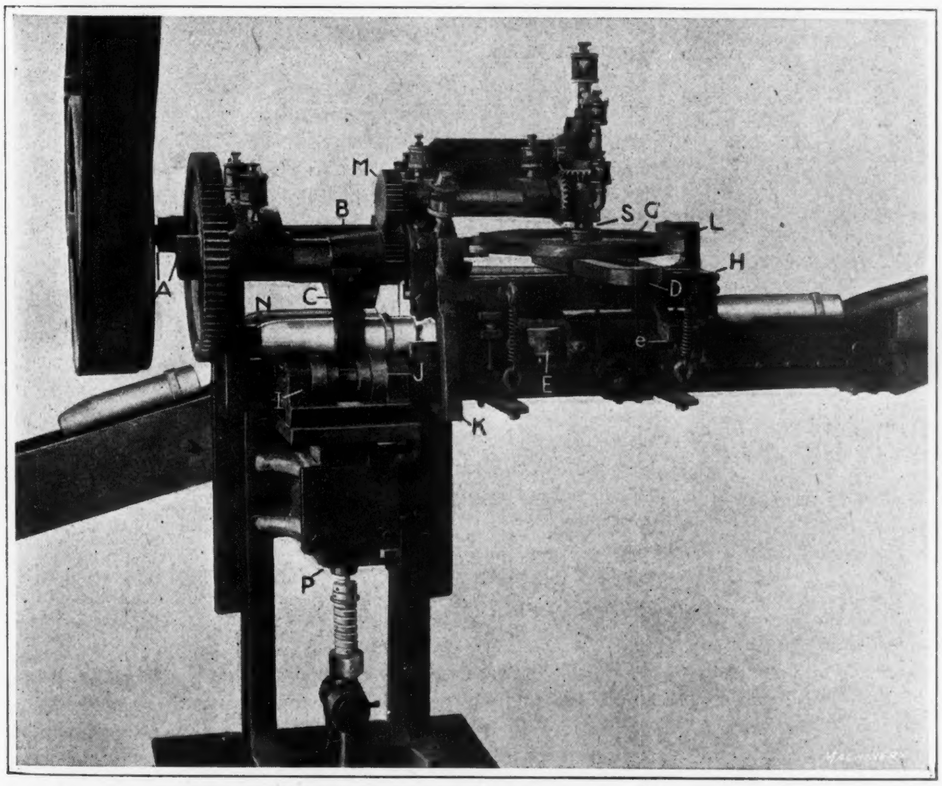


Fig. 1. Automatic Shell Marking Machine with Shell in Position to be ejected after having been marked

While the marking and ejecting operations are being performed the trigger holder is on its backward stroke. Simultaneously, brake *K* has been forced

down and the brake e raised by the action of the cam, allowing the next shell to advance on the conveyor rolls until stopped by brake K about one-half inch from the shell that is being stamped. The trigger, as it hangs in the holder, which is in reality a slide, drags over the top of the shell that is in position against brake K on its backward stroke, and upon arriving at the extreme end of the stroke drops and catches the shell as in the previous case.

Variations in diameter of the shells are compensated for in the conveyor by a special construction. It will be observed that the longitudinal guide H which supports the cam and cross-guide mechanism is hung by coil springs attached to straps on the under side of the conveyor by means of four eye-bolts, two on each side of the conveyor. This flexible construction provides for variation in the diameter of the shells. This variation in diameter is also taken care of after the shells are in position to be stamped in the cradle. The carriage P is provided with a yielding type of support which is mounted in a bearing at the base of the machine. A screw for adjusting the carriage vertically fits into a heavy square-coiled spring which is held by a collar. The tendency of the force exerted by the expansion of the spring is against the carriage and results in producing an equalized depth of impression on the shells.

Fig. 2 shows the shells as they are being ejected and deposited in the conveyor that leads to the last operation prior to shipping, that of lacquering the shells. F. R. D.

* * *

GOVERNMENT COMMISSION ON SCREW THREAD STANDARDIZATION

The commission for the standardization of screw threads authorized by Congress has been formally appointed by the Secretary of Commerce. The commission consists of nine members; the chairman is Dr. S. W. Stratton, director of the Bureau of Standards. The remaining eight members represent, respectively, the United States Army, the United States Navy, the American Society of Mechanical Engineers, and the Society of Automotive Engineers, two members representing each body. The representatives of the Army are Colonel E. C. Peck and Major O. B. Zimmerman; the representatives of the Navy are Commander S. M. Robinson and Commander E. J. Marquart; the representatives of the American Society of Mechanical Engineers are James Hartness of the Jones & Lamson Machine Co., Springfield, Vt., and F. O. Wells of the Greenfield Tap & Die Corporation, Greenfield, Mass. The representatives of the Society of Automotive Engineers are E. H. Ehrman and H. T. Herr. There are also associated with the commission the following men as secretaries: H. W. Bearce, general secretary; H. L. Van Keuren, executive secretary, and Robert Lacy, assistant secretary.

The commission has been divided into four committees as follows:

1. Committee on Pitches, Systems, and Form of Thread: F. O. Wells, Commander S. M. Robinson, E. H. Ehrman, H. T. Herr, and H. W. Bearce.
2. Committee on Tolerances and Classification: James Hartness, E. H. Ehrman, Colonel E. C. Peck, and H. L. Van Keuren.
3. Committee on Nomenclature and Terminology: F. O. Wells, Commander E. J. Marquart, Major O. B. Zimmerman, and Robert Lacy.
4. Committee on Gages and Methods of Testing: Colonel E. C. Peck, James Hartness, Commander E. J. Marquart, and H. L. Van Keuren.

Duties of Commission

The duties of the commission are to ascertain and establish standards for screw threads, which shall be submitted to the Secretary of War, the Secretary of the Navy, and the Secretary of Commerce for their approval. The standards adopted and approved shall be used in all manufacturing plants under the control of the War and Navy Departments and, insofar as practicable, they will be used in specifications for screw threads in proposals for manufactured articles, parts or materials to be used under the direction of these departments. It is also the intention that the Secretary of Commerce shall endeavor to have such standards accepted for use by manufacturers in general.

Meetings of the Commission

The first meeting of the commission was held in Washington, D. C., September 23 and 24. At this meeting a tentative program of the activities of the commission was outlined. It is the intention to conduct several hearings on certain topics relating to the standardization of screw threads; these hearings will be held in a number of industrial centers, as well as in Washington, and some of them have already been conducted. The object of these hearings is to secure data and information and to obtain the viewpoints of manufacturers and users of screw-thread products. With the information secured as the result of these hearings the work of the commission, in establishing national standards for the various requirements of threaded work and in determining tolerances for interchangeable manufacture of different classes and grades of work, will be greatly facilitated.

First Hearing Conducted by the Commission

The first hearing conducted by the commission was that in New York City on October 7, subsequent hearings taking place in Dayton, Ohio, Detroit, Mich., and elsewhere. An invitation was extended to manufacturers and users and other parties interested in screw thread products to be present at these hearings and express their opinions. The questions considered were as follows:

1. As a national standard, is there any objection to the continuation of the U. S. standard system of thread diameters and pitches for general use in practically its present shape?
2. As a national standard, is there any objection to the adoption of the S. A. E. system of diameters and pitches of fine threads?
3. As a national standard, to what extent could the A. S. M. E. system of standard machine screws be adopted?
4. There seems to be a general feeling that in standardization we should make it possible to cover several classes of work and there has been suggested a minimum of four classes of fits to provide for different grades of work ranging from reasonably wrench-tight fits to very loose fits. Would such a classification, including at least four classes, be sufficient for all grades of work encountered in the various systems of threads previously mentioned or would a classification including more than four classes be required?
5. Is there any objection to adopting the "standard hole" practice for screw threads; that is, the practice of making all the taps for any particular thread of one basic size and securing the required fit by changing the diameter of the screw or male threaded work which is to assemble with the nut cut by the basic tap?

The answers to these questions were as recorded below. Nearly all the manufacturers and users of screw thread products present answered "Yes" to questions 1 and 2, in certain cases with qualifications. Question 3 was also, in general, answered "Yes," except that several manufacturers and users qualified this answer with the statement that as a national standard only the sizes from No. 0 to No. 14 were required. The answers to question 4 were, on the whole, in agreement on the point that only three and four different classifications were required. There was also a fairly general agreement relative to question 5, and there was no serious objection raised to the adopting of the "standard-hole" practice for screw threads.

* * *

In order to reduce as far as possible the difficulties incident upon delay in the transmission of shipping documents, the Censorship Board requests that exporters write upon the envelopes containing such matter the words "Shipping Documents." When this is done, no avoidable delay in the examination and returning of the documents will result.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

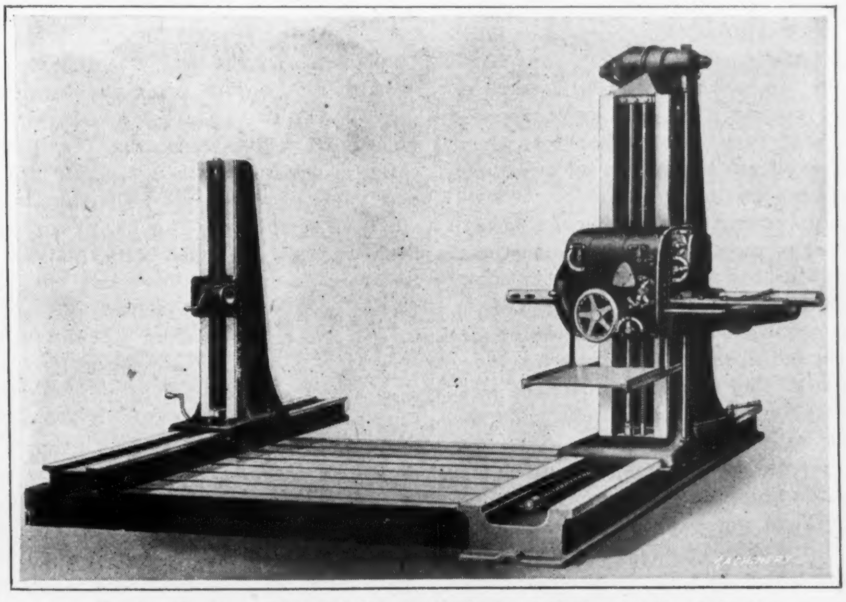
GIDDINGS & LEWIS BORING, DRILLING, AND MILLING MACHINE

This machine has been especially developed to meet the requirements of shipyards and other plants engaged on heavy government work for boring mills adapted to their needs. In general features of design, the machine is constructed quite closely in accordance with standard practice, but many of the details have been cleverly modified to add to the speed and facility with which operations can be formed. Complete information is given in regard to these features.

To meet the requirements of numerous plants engaged in the execution of government orders, and more particularly in shipyards and other establishments where the heavier kinds of machine work have to be done, there has been an unusually urgent demand for a large-sized floor-type boring mill. To assist in filling this demand, the Giddings & Lewis Mfg. Co., Fond du Lac, Wis., has recently placed on the market a No. 4 horizontal floor-type boring, drilling, and milling machine which is here illustrated and described. This machine has a spindle 5 inches in diameter, and its design has been worked out to provide for machining those pieces which are of a shape and size that make it impossible to handle them on many types of machine tools. In working out the general arrangement of the members on this boring mill, the designers have followed somewhat along the lines of standard practice, the machine consisting of a balanced headstock which is adjusted vertically by sliding it on the column ways, and providing means of horizontal adjustment by sliding the column on a runway on the bed. This runway is secured to a large floor plate provided with T-slots for securing work-holding fixtures or the work to be machined.

At the outer end of the floor plate there is a support which carries the outer bearing for the boring-bar. The bearing of this support is adjustable vertically and horizontally in the same manner as the headstock, and the whole end support may be moved toward or away from the column in order to provide for supporting the boring-bar as close to the work as is possible. This simple, though complete, machine provides means of performing any of the operations required for finishing a piece such as boring, drilling, milling, tapping, threading, facing, turning, or slotting. While the general design follows fairly close along the lines of standard practice, many members have been cleverly designed to afford convenience and rapidity of operation, which greatly facilitates rates of production. In many cases, suitable fixtures may be constructed to make it possible to machine five sides of a casting accurately at a single setting of the work.

A feature which greatly simplifies the operation of this machine is that the driving mechanism is contained in the headstock and all operating levers are located within easy reach of the operator who rides upon a platform swung from the headstock. The floor plate is bolted and doweled to the runway, and both of these members are provided with ample support on the foundation. Cross ribs assure the maintenance of a permanent alignment of these members, and another feature is that the floor plate is machined all over to afford convenience in gaging and accurately aligning the work. The column is liberally proportioned to withstand all strains to which it is subjected, and the bottom surface spreads out in all directions to provide a generous sized bearing on the ways. Lost motion between the column and its ways is eliminated by means of long tapered and square locked gibs. Although the end support is not subjected to such severe



No. 4 Floor-type Horizontal Boring, Drilling, and Milling Machine built by Giddings & Lewis Mfg. Co.

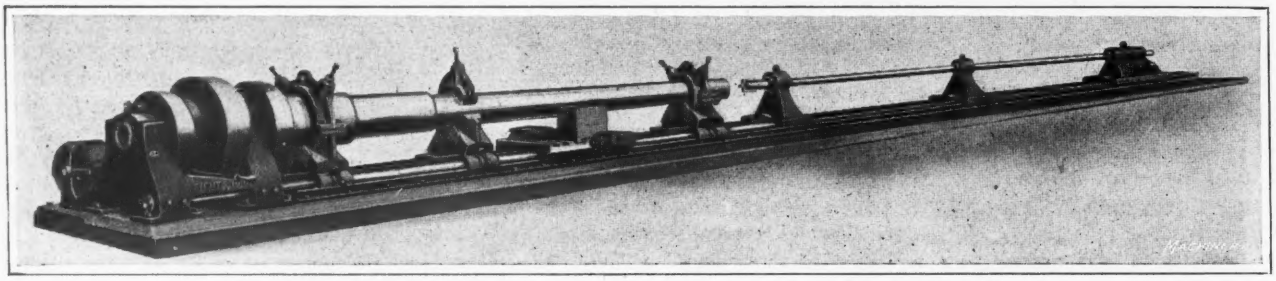
strains as the column, it is made of ample size to provide plenty of support for the boring-bar when working under the most severe conditions. It is good practice to place the support as close to the work as practicable, this being accomplished by sliding the support over the floor plate on which it is guided by a long key. The end support is entirely independent of the remainder of the machine, and may be easily removed when it is desired to provide extra space for setting up unusually large pieces of work on the floor plate.

The headstock is of box design and constructed in a manner to provide plenty of support to all moving parts. All lost motion between the headstock and its bearings on the column is taken up by means of two tapered and square locked gibs. A removable cover is provided which makes it an easy matter to adjust the spindle sleeve bearing and to make other inside adjustments. Located at the top of the headstock and within easy reach of the operator, there are oil reservoirs which supply lubricant to all of the bearings. The operator's platform moves with the headstock so that the operator is always in a position to reach all the control levers. The center of the spindle is located unusually close to the face of the column, thus reducing overhang to its practical minimum. The spindle is made of a steel forging carefully heat-treated and ground to size. At the front end, it is bored to receive the Morse taper shank, tang, and drift key, while the back end is equipped with a ball thrust bearing. Feed motion is transmitted through the use of a long ram carrying the rack which disengages with the pinion at both extreme positions. Power is transmitted to the spindle from the sleeve, by means of two splined keys which are placed diametrically opposite each other. At each end of the sleeve a take-up collet is provided, and by its adjustment precise alignment is secured. The sleeve is also made of heat-treated steel, and it runs in two liberally proportioned adjustable bronze bushings, provided with independent means of compensating for wear.

Two large driving gears are secured to the spindle sleeve, the front or face gear being the larger. Power is transmitted through a variable-speed unit located at the upper right-hand corner of the headstock, which contains heat-treated steel gears with cut teeth of the stub form. High-speed shafts in this unit are provided with ball bearings, and all heavy-duty shafts are furnished with generous sized phosphor-bronze bearings. Power for operating the feed unit is transmitted from the speed unit through a set of change-gears carried on a quadrant; and by means of this change-gear unit, the extremes of maximum and minimum feed may be obtained when required to meet the needs of exceptional work. Extra change-gears are not supplied as regular equipment, because the regular range of feeds covers the requirements of all ordinary work done on a machine of this type. Feed gearing is carried in the headstock at the lower right-hand corner, the gears being made of heat-treated steel with cut teeth of the stub form, the same as those in the speed unit. In working out the design of the feed unit, care has been taken to provide for obtaining the maximum number of changes with the minimum number of gears.

With the exception of the spindle, all feeding movements are obtained by means of long phosphor-bronze nuts equipped with ball thrust bearings which revolve on accurately cut lead-screws of large diameter and coarse pitch. These screws are firmly anchored at each end to eliminate any possibility of their buckling. The rapid traverse is independent of the feed and derives its movement directly from the initial drive. The movement is always in the opposite direction to the feed which is being used, and is controlled by interlocking levers which make it impossible to engage the rapid traverse and feed movements simultaneously; but by placing the feed reverse lever in the neutral position, the rapid traverse can be engaged in either direction. Safeguards are provided to automatically guard against damage to all parts of the mechanism.

The principal dimensions of this machine are as follows: Diameter of spindle, 5 inches; length of spindle, 108 inches; continuous feed of spindle, 48 inches; taper of hole in spindle, No. 6 Morse; maximum distance from spindle center to floor plate, 92 inches; minimum distance from spindle center to floor plate, 20 inches; size of floor plate, 8 by 12 feet; maximum distance from faceplate to outer support, 124 inches; diameter of spindle sleeve front bearing at large end of taper, 9¾ inches; diameter of spindle sleeve rear bearing, 7 inches; number of available spindle speeds, 12; range of available spindle speeds, 4 to 160 revolutions per minute; number of available feeds without changing gears, 16; range of available feeds without changing gears, 0.0037 to 1.08 inch per spindle revolution; number of available feeds by changing gears, 48; range of feeds by changing gears, 0.0007 inch to 5.40 inches per spindle revolution; vertical travel of head on column, 72 inches; horizontal travel of column on runway, 96 inches; surface of column bearing on runway, 40 by 64 inches; rate of rapid traverse in all directions, 4 feet per minute; size of motor required to drive machine, 15 horsepower; recommended speed for motor, 1200 revolutions per minute; diameter of face gear, 24 inches; pitch of face gear, 3; total height of machine, including motor, 13 feet 4 inches; floor space occupied by machine, 16 feet by 24 feet 6 inches; size of keyways in spindle, ¾ inch; and weight of machine, 38,000 pounds.



Gun Boring and Turning Lathe built by David A. Wright, in which the Bed is made of Concrete

WRIGHT GUN BORING AND TURNING LATHE

David A. Wright, 568 Washington Blvd., Chicago, Ill., is now building a gun boring and turning lathe in sizes ranging from 42 to 120 inches swing, with any required length of bed. It will be seen from the illustration that this machine is designed with a concrete bed in which is set one way made of ground-steel shafting, while the other way is made of cast iron. The boring-bar bracket, carriage, and headstock are equipped with individual motor drive, and gear-boxes provide the necessary changes of speed and feed. Owing to the peculiar features of its design, this lathe can be shipped in a minimum amount of space, and where the necessary precautions are taken, it is stated that no trouble is experienced in having all members in accurate alignment. It is recommended that the following procedure be followed in lining up the machine. The ground-steel shafting is lined up from the spindle, after which it is solidly babbitted into the headstock. After this work has been completed, the rear way is brought into alignment. When so desired, machines of this type may be equipped as double-end boring and turning lathes. Patents have been applied for on certain features of this lathe construction.

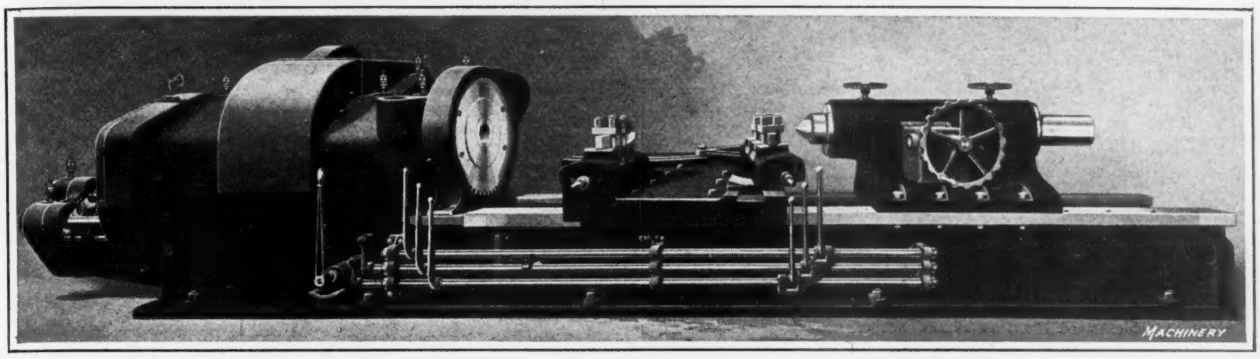


Fig. 1. No. 47 Heavy-duty Lathe built by the Amalgamated Machinery Corporation for turning Shells from 12 to 20 Inches in Diameter by 3½ to 9 Feet Long

AMALGAMATED SHELL TURNING AND BORING LATHES

The scarcity of heavy machine tools to meet the requirements of the Government for the making of large guns, shells, and other munitions of war has been emphasized time and again, whenever Ordnance Department officers have met with machine tool builders in conferences or at conventions. The Amalgamated Machinery Corporation has taken steps to meet the demand for various machines of heavy type, and the lathes here described have been specifically designed for the single purpose of turning and boring large shells—those of 12 inches in size and larger. One machine is used for turning and one for boring, each being provided with features that adapt it especially for that one operation. As the largest shells that can be handled in these machines are 20 inches in diameter by 8 or 9 feet in length, the necessity for machines of heavy construction, powerful drive, simplicity of control, and ample proportions generally, will be appreciated.

The Amalgamated Machinery Corporation, 72 W. Adams St., Chicago, Ill., has just brought out two new shell-making machines, a shell turning lathe, as shown in Fig. 1, and a shell boring lathe, as shown in Fig. 2. These machines have been especially built for turning and boring shells from 12 to 20 inches in diameter, these shells, according to size, being from 3½ to 9 feet in length. Shells of these dimensions cannot be handled to advantage on standard machine tools, and in the design of the machines to be described, therefore, many special features have been introduced, with a view to adapting them specifically to the work for which they are intended, insuring both the required accuracy in the machining and the speed necessary to obtain a satisfactory production. The machine shown in Fig. 1, and also in the line engraving Fig. 3, is known as the Amalgamated No. 47 turning machine. Its total length is 30 feet; maximum width, 5 feet; and maximum height over the headstock, 6½ feet.

Driving Mechanism

The main drive to the machine is by means of a 12-inch belt on pulley *A*, Fig. 3. This pulley is 16 inches in diameter, and runs at a constant speed. By means of the gear-box provided, four spindle speeds are obtainable, each being so selected that a 12-, 14-, 16-, or 18-inch shell can be run at a uniform surface cutting speed per minute, according to which one of the four available gear combinations is thrown into action. The machine is started and stopped by means of a friction clutch of the contracting-band type, located on the right side of the driving pulley.

The details of the driving arrangement are more clearly shown in Fig. 4, where the gear-box, spindle drive, and feed mechanism are separately illustrated. Here the main driving pulley is again designated as *A*, with its connecting friction clutch on the right-hand side. When the clutch is thrown in, shaft *B*, which is keyed to it, will be caused to revolve, and with it the four sliding gears mounted upon it and keyed to it. By shifting these gears to mesh with each of the four corresponding gears on shaft *C*, the four selective spindle speeds are obtained, the drive being through spur gearing to shaft *D*, and thence to the spindle *E*. The latter is driven from shaft *D* by two sets of spur gears, *F* and *G*, and *H* and *J*, as shown. The object of this arrangement is to provide a steady and equal torque on the spindle at each end of the main spindle bearing. To further steady the drive, and to prevent any possibility of jerky action, the pinions *F* and *H* are so keyed to shaft *D* that a tooth in one of them comes exactly opposite a tooth space in the other, that is, the teeth in the two pinions are staggered relative to each other. The sliding gears on shaft *B* are of 3 diametral pitch, the gears connecting shafts *C* and *D*, of 2½ diametral pitch, and the spindle driving gears, of 2 diametral pitch. This gives an idea of the powerful features of the driving mechanism.

The spindle *E* is a solid forging, 7 15/16 inches in diameter, and 7 feet 3 inches in length. It is provided with a taper hole at its end for a live center, so that the machine may be applied to work that would be held on centers as well as for work held on the faceplate or in a chuck fastened to the faceplate. The driving gear *J* also acts as a faceplate, this arrangement avoiding any unnecessary overhang, and providing a direct faceplate drive without any eccentric torque. The chuck is fitted to a male projection on the faceplate gear and held to it by through bolts. All gears are made of steel.

The end thrust on the spindle is taken by a disk thrust bearing immediately to the left of gear *J*, this bearing consisting of alternate disks of chrome-nickel steel and bronze, the steel disks being hardened and both steel and bronze disks being ground and running in a bath of oil. A chain lubrication arrangement is also provided for carrying the lubricant from the oil reservoir at the bottom to the top of the disks. In order that any wear in the lateral direction

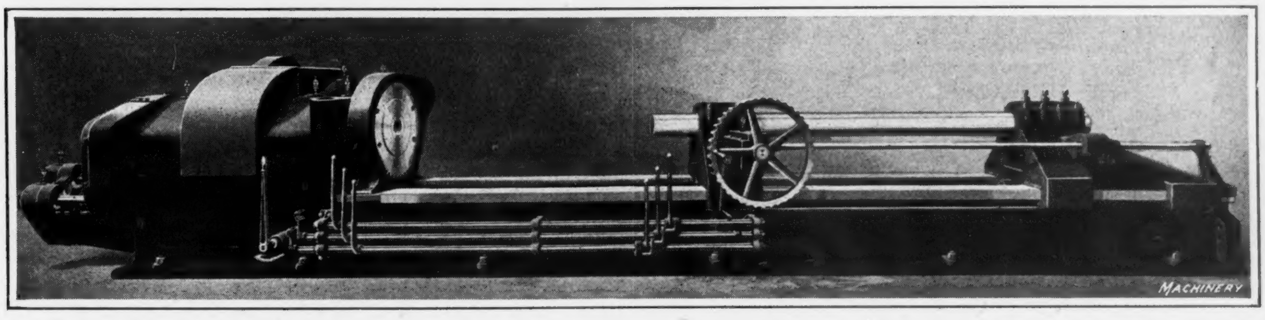


Fig. 2. No. 46 E Heavy-duty Lathe built by the Amalgamated Machinery Corporation for boring Shells from 12 to 20 Inches in Diameter by 3½ to 9 Feet Long

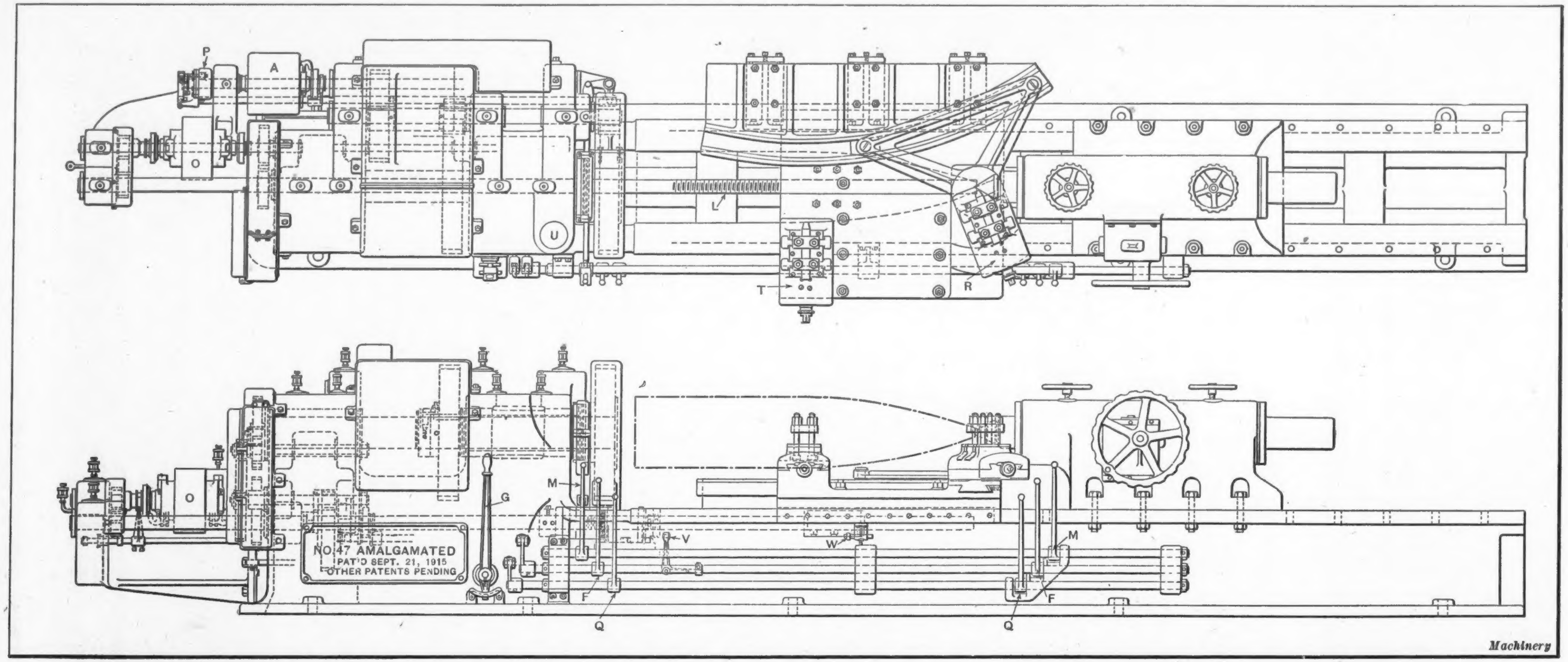


Fig. 3. Front and Plan Views of the No. 47 Amalgamated Shell Turning Lathe shown in Fig. 1. This Illustration shows more clearly Many of the Features of the Equipment of this Machine

of the spindle may be adequately taken up, a set of steel and fiber washers are provided immediately to the right of gear *G*, and an adjusting nut threaded onto the spindle is placed at the left of the gear. In this way the spindle with its thrust bearing can always be drawn up tightly against the end of the bearing bushing of the main spindle bearing.

In order to provide means for rapidly stopping the machine when the clutch of the driving pulley *A* is thrown out, a brake mechanism is provided outside of the outboard bearing, to the left of the driving pulley. This brake mechanism is operated by the same lever that operates the clutch; the movement of this lever first releases the clutch, and a continued movement applies the brake. The latter consists simply of a wooden cone operating inside the projecting extension of the casting to the left of the outboard bearing, as indicated at *P*, Fig. 4.

Feed Mechanism

The feed to the carriage of the lathe is by means of a feed-screw located in the center of the machine, midway between the shears. This provides a smooth feeding action to the carriage and requires the minimum amount of power to drive the feed mechanism, as the carriage is moved along by a direct push or pull, and not by an eccentric pulling action as would be the result if the feed-screw were located in front of the machine. In that case, the eccentric pull would create a tendency to bind the carriage on the ways, greater power would be required, and there would be danger of stripping the feed-gears, unless these were made unduly heavy. All these difficulties are eliminated by locating the feed-screw centrally between the shears.

The drive for the feed-screw is shown in detail in Fig. 4, and consists of a train of gears starting with gear *I*, on the end of spindle *E*, this train transmitting motion to feed clutch shaft *K* whenever clutch *M* is thrown into operation. Feed-screw *L*, in turn, is driven by shaft *K* through an Oldham coupling at *N*, which takes care of any slight discrepancies of alignment that may exist between shaft *K* and screw *L*, and thereby assures freedom from any binding action in the bearings. Immediately to the right of coupling *N* a disk thrust bearing for taking the end thrust of the feed-screw is provided, similar to the thrust bearing used for taking the spindle thrust. The feed-screw is 3 7/16 inches in diameter, 8 feet 8 inches long, and provided with 2 threads per inch, Acme single threads.

Change-gears are provided at *R* and *S* by means of which the feed may be varied by small intervals from 0.070 to 0.500 inch per revolution of the spindle, but usually no feed changes are required for shell turning as one standard feed

can be adopted that will suit all the shells of the sizes for which the machines being described are intended. Should a change in feed be desired, however, the gears may be rapidly changed, as they are readily accessible through a hinged door in the end of the gear-case which encloses the feed-gears.

When it is desired to move the carriage rapidly, either at the end of a cut for rapid reverse or for other reasons, this may be done by operating the rapid traverse mechanism shown to the left in Fig. 4. By means of this, the carriage may be moved in either direction at a rate of six feet per minute. Pulley *O* is driven from the countershaft, and normally runs idle on its shaft. A clutch is provided on each side of this pulley, and as either one or the other of these clutches is thrown into engagement with the pulley, the carriage will be moved rapidly in the required direction. As indicated, the shaft on which pulley *O* is mounted is connected by gearing to the feed clutch shaft *K*, the gears to the right being in a direct train, while those to the left have a reverse gear introduced. The operation of all clutches, both for the driving and the feed mechanisms, is by means of levers that will be referred to later.

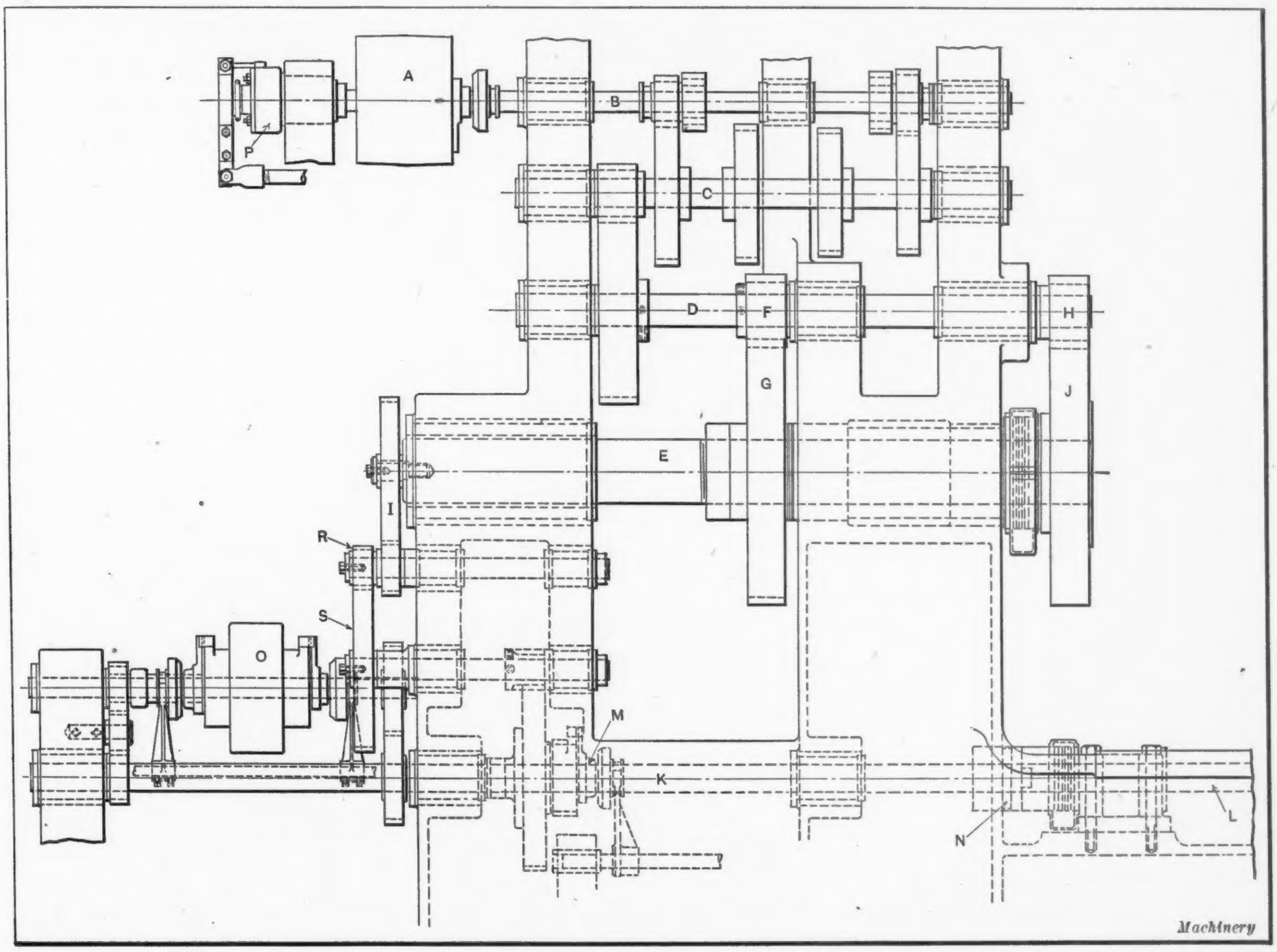


Fig. 4. Driving Gearing for Spindle and Feed Mechanism of Shell Turning and Boring Machines

Carriage

The carriage construction is shown in detail in Figs. 5 and 6. Fig. 5 shows a top view and a front elevation, while Fig. 6 shows end views and sections of the front and rear tool-slides, respectively. The top view shows the so-called taper tool-slide, *T*, in Fig. 3, while the lower view shows the radius tool-slide, *R*, in Fig. 3. In the assembly illustration, Fig. 3, is also clearly shown the purpose of the two tool-slides, the taper tool-slide turning the slightly tapered rear end of the shell, while the radius tool-slide turns the pointed nose. Figs. 5 and 6 indicate how these slides are guided. The taper tool-slide is provided with an extending arm on the end of which is mounted a block which follows a groove or slot in the cam or guide *H*, which latter is made to the required shape of the shell, and is adjustable to suit any slight variation that may be necessary in the machining of the shells. The tool-slide itself has simply a back and forth motion away from or toward the center of the machine.

The action of the radius tool-slide *R* is somewhat more complicated. The guide *K* is formed to a circular arc having the same center as the arc to be formed on the shell. From the tool-slide two arms extend having blocks that engage with the guide. As the carriage moves along the bed of the machine, it brings the tool-slide with it, but a swivel joint *L* is provided between slides *C* and *D*, so that the upper part *C* with tool-slide *E* is free to turn about pivot *L*; and hence the tool point is given a motion along an arc of a circle as required by the shape of the shell nose. Not only is the point of the tool guided along an arc of a circle, but by the guiding and swiveling combination, it will always be in a position at right angles to the work being turned, which is a highly important feature in the design of these machines, and one that is found only in them, as the application of this principle is protected by patents.

Referring now to the detail construction of the carriage, it will be seen from Fig. 6 that the feed-screw *M* passes through a nut bolted to the under side of the carriage. The length of this nut is 15 inches, and it is held to the carriage by six 1-inch bolts. That part of the carriage that rests directly upon the bed or shears, as indicated at *A*, is known as the "master carriage." It remains the same for all sizes of shells, and is permanently in place, but the upper part *B* of the carriage, together with the slides and toolposts, is changed for different sizes of shells. The guides or cams are also changed. At present, the machines are intended especially for four sizes of shells (12-, 14-, 16-, and 18-inch), and hence there are four sets of guides and slides. The bracket *F*, Fig. 6, at the rear of the machine remains permanently in place, but parts *H* and *K* into which the guides are cut, are changed. These changes can be made rapidly,

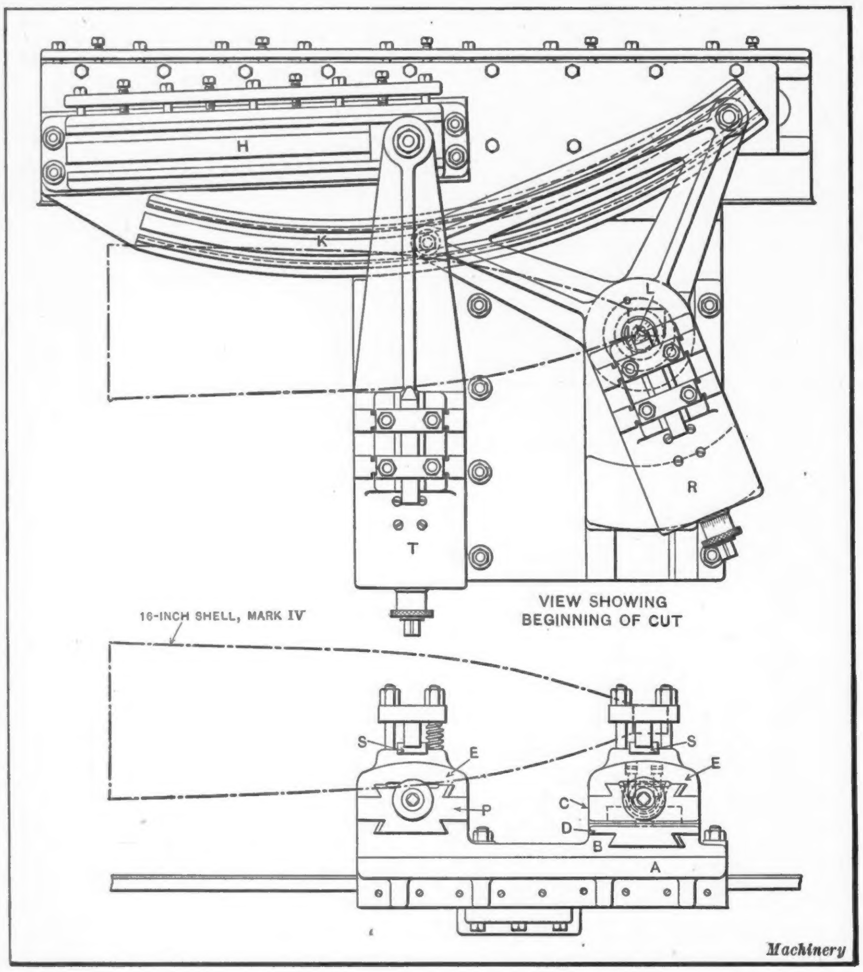


Fig. 5. Plan and Front Elevation of Carriage and Tool-slides of Shell Turning Machine

as all that is required is the manipulation of a few bolts.

The top slide *E*, known as the tool-slide, is simply for adjusting and setting the tool. The latter is 2 by 3 inches in section, and rests in a shoe *S*, Fig. 5, which is roughened or serrated on the surface against which the tool rests. Slide *P* of the taper tool-slide and *D* of the radius tool-slide is the slide which moves with the guide, while *C* in the radius tool-slide is the swivel that permits the tool always to occupy a radial or right-angled position with regard to the nose of the shell.

Headstock and Tailstock

The bed and the headstock are cast in one solid piece, this casting weighing about 15 tons. In the headstock a 7-inch hole is provided at *U*, Fig. 3, for the post of a small jib crane for handling the shells. The bearings throughout, with two exceptions, are of the well-known Amalgamated tight-metal construction; the exceptions are the main spindle bearing and the front tailstock bearing. The main spindle bearing consists of a babbitted cast-iron bushing, which is carefully fitted into a bored and reamed hole in the headstock casting. The front tailstock bearing is constructed in a similar manner, except that it is not babbitted, the bushing being bored and reamed to fit the tailstock spindle.

The general construction of the tailstock is shown in Fig. 3. The large handwheel in front of the tailstock moves the spindle in a longitudinal direction through a train of bevel gears, worm and wormwheel, and a pinion and rack, the latter being attached to the under side of the tailstock spindle. The two handwheels on top of the tailstock are for binding the spindle, a key in a spline on the upper side of the spindle being provided for that purpose. The shells would ordinarily be held by the tail-center at the nose end, and by an expanding arbor at the other end; but the method of holding the shells varies with the type of the shell being turned. The tailstock is held to the bed by bolts, as indicated, and may be moved to any position required by the length of the shells to be machined.

Operating Levers

The operation of the machine is simple in that there are only a few operating handles to manipulate. As shown in Figs. 1 and 3, the levers are all placed in front of the machine, within easy reach of the operator. In Fig. 3, *G* is the gear shifting lever, which has four positions, one for each of the sliding gears; *M* is the main driving pulley clutch lever; *F* is the feed clutch lever; and *Q* is the rapid traverse lever. The last three levers are mounted on operating shafts, and a second set of levers is provided at the rear end of the machine, as shown, so as to save the operator from changing his position if he should be working at the tailstock end of the machine. The front levers are stationary on the operating shafts, but the rear levers are mounted in a bracket, as shown, so that they may be moved from one position to another on the shafts, to suit the convenience of the operator. As already mentioned, the driving pulley clutch lever also operates the brake. The operating

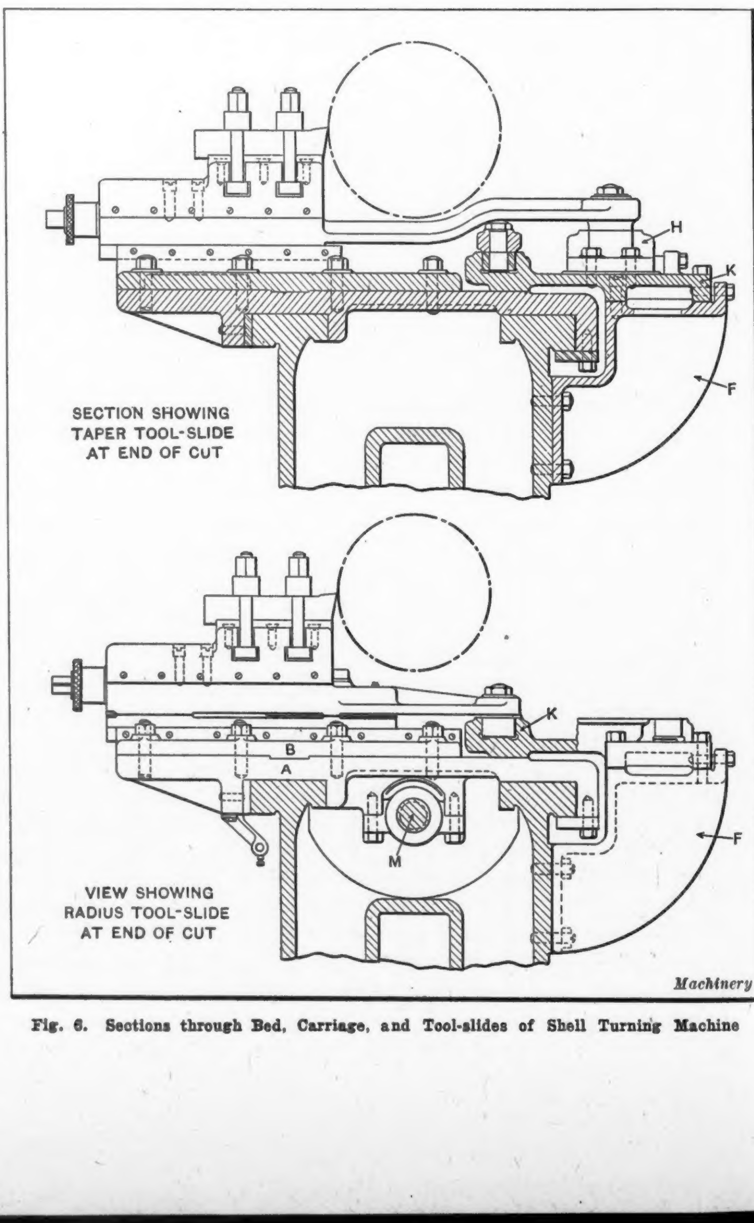


Fig. 6. Sections through Bed, Carriage, and Tool-slides of Shell Turning Machine

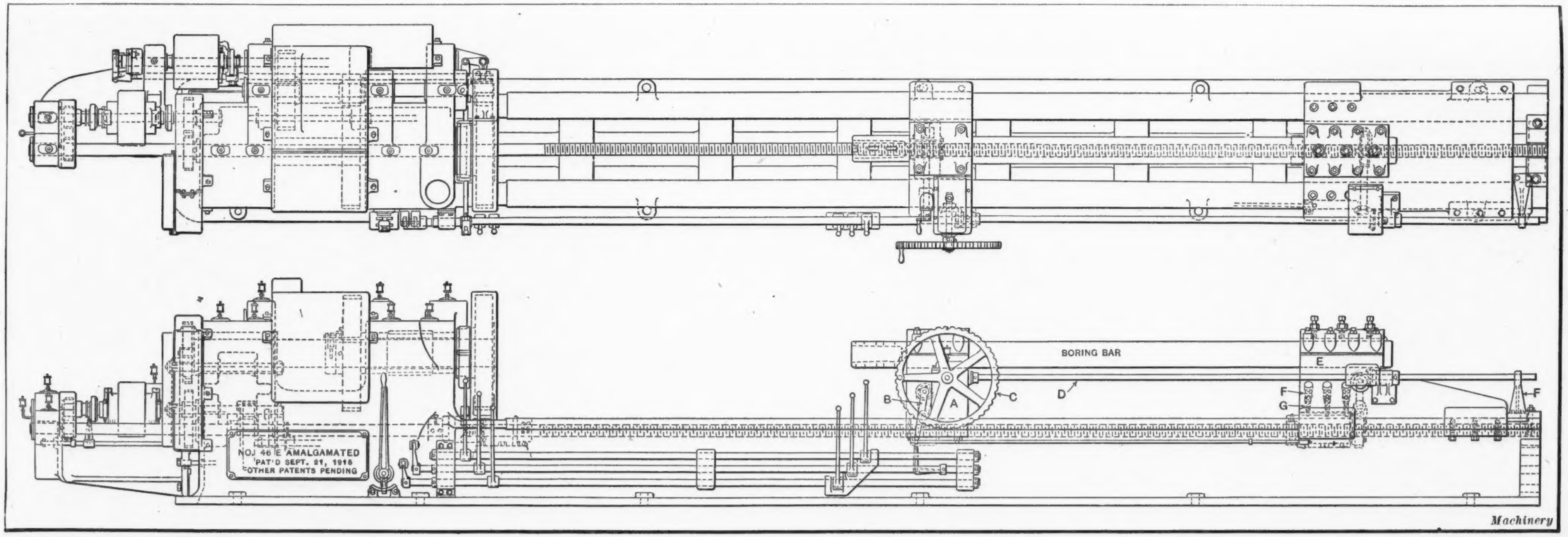


Fig. 7. Front and Plan Views of the No. 46 E Amalgamated Shell Boring Lathe shown in Fig. 2. This Illustration shows Many of the Features of this Machine more clearly

levers are connected with their respective clutches by bell-cranks, shafts, and levers. In addition to the hand-operated feed clutch lever, an automatic feed release is provided at *V*. This is merely a lever that is actuated by a throw-out pin *W* mounted on the carriage.

Shell Boring Machine

The boring machine shown in Fig. 2 and in the line engraving Fig. 7 is known as the Amalgamated No. 46 E boring machine. Its length over all is 36½ feet, while the height over the headstock and width are the same as in the shell turning machine just described. The driving mechanism, feed gearing, and other features of the headstock are the same as in the turning machine, and, hence, need no further description. The feed-screw, however, is considerably longer, its total length being 26 feet. Hence, it has an outboard bearing at its end, which the feed-screw of the turning machine does not need. The bed is also of the same pattern as that of the turning machine, but the carriage is of entirely different construction. At *E*, Fig. 7, is shown the boring-bar carriage, in which is clamped the boring-bar, the latter being 7 15/16 inches in diameter and 11½ feet long. This bar is clamped in the carriage by the cap and eight bolts. A key on the top of the bar, held in place by three screws through the top of the cap, also clamps the bar and prevents it from rotating, which is a necessary and important feature on the heavy work to be done in these machines.

The carriage is fitted on its under side with a nut for the feed-screw. An interesting feature is introduced in the form of a worm-wheel attached to the nut, by means of which the nut may be rotated in the bearing in which the outside of it fits, so that thereby the feed motion of the carriage may be either accelerated or retarded slightly as compared with the motion obtained directly from the feed-screw. The handwheel *C* on the boring-bar guide or rest *A* serves the purpose of manipulating the feed-nut of the carriage through a series of gears and shaft *D*. The handwheel *C* is placed on the boring-bar guide *A* instead of directly on the carriage in order that it may be near the position occupied by the operator when the machine is running.

An important feature of the carriage is the method of taking care of the strains set up by the end thrust from the boring-bar. It is evident that this end thrust will tend to lift up the carriage at the front end and press it downward against the shears at the rear end. Hence, the construction generally followed in the design of machines of this kind has been abandoned, and a special design introduced. Instead of having a gib at the front end beneath the shears, the carriage casting has been made in a kind of hook shape, embracing the shear and thus transferring the upward thrust directly from the carriage casting to the under side of the shear. A gib is then fitted on the top on the shears, between the carriage and the top of the bed, where there is no direct pulling strain on the gib. Screws *G* are the adjusting gib screws, and screws *F* are binding or lock-screws for screws *G*. At the rear end of the carriage, where the thrust is downward, the conventional design, with a gib at the under side of the shear, has been followed.

The boring-bar guide or rest *A* ordinarily remains in one position while the machine is operated; but occasionally it will be necessary to move it along the bed, as for example, when a new size of shell is to be handled. In order to facilitate this, a half-nut is provided that may be brought into engagement with the feed-screw. This half-nut is manipulated through lever *B* and an eccentric, by means of

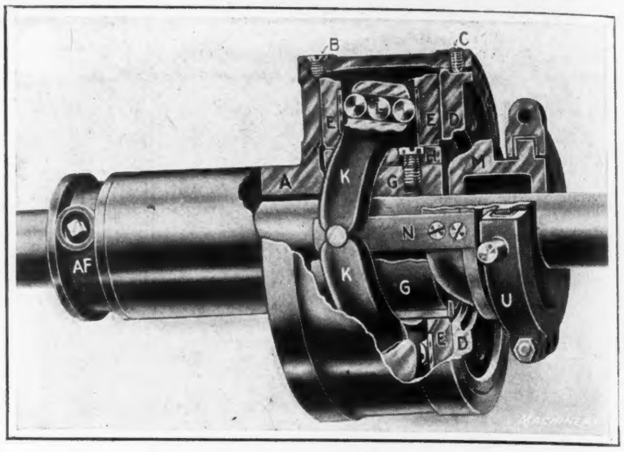
which the half-nut is temporarily lifted out of or brought into engagement. The hole in guide *A* that receives the boring-bar is bushed with a cast-iron bushing, bored and reamed to a sliding fit for the bar. This bushing, in turn, is held in place in the guide casting by being clamped by the cap above.

The particular features of these machines that are especially emphasized by the builders are the heavy and rigid construction; the spindle drive, that prevents any eccentric torque at the front end of the spindle and hence the wearing of a bell-mouthed hole at this end; the combination driving gear and faceplate; the feed-screw in the center of the machine; the arrangement by means of which the motion of the radial slide of the turning machine is controlled, making it possible always to present the tool properly to the work, and avoiding any stepped effect in turning the nose of the shell; the gib arrangement on the carriage of the boring machine; and the fact that by the construction methods employed and the elimination of all unnecessary machine work, the machines may be rapidly produced, a feature of the greatest importance at this time.

"AKRON" FRICTION CLUTCH

In the "Akron" friction clutch, illustrated herewith, which is a recent product of the Williams Foundry & Machine Co., Akron, Ohio, simplicity of design is one of the important features claimed by the manufacturers. This may not appear true upon first referring to the illustration, but, after making a more careful study of the clutch construction, the reader will appreciate that the design is more simple than it appears at first sight. The following gives a brief description of the clutch members and the way in which they operate. Drum *A* carries a hub or sleeve to which pulleys, gears, or sprockets may be keyed. The head *D* is separate. Within the drum there are arranged two cast-iron friction plates *E* with keys *H* sunk into the driving member *G* to provide for the rotation of plates *E* with the shaft. These plates are free to move laterally on keys *H*, and the clutch depends for its power transmitting capacity upon the friction between disks *E* and the corresponding friction surfaces of drum *A* and cover *D*. Engagement of the clutch is accomplished by forcing apart disks *E* so that they come into contact with their respective friction surfaces, this engagement being accomplished by operating a toggle mechanism. This mechanism is connected by steel links *N* to sliding sleeve *M*, shifter forks attached to yoke *U* being employed to throw the clutch into engagement.

The roller toggle mechanism is one of the important features of design of the "Akron" clutch. It will be seen to consist of two forked levers *K* with holes through them in which are lodged three hardened tool steel balls *L*. When the levers *K* are perpendicular to the shaft, the line of centers of the three balls or rollers is perpendicular to the faces of the friction disks, causing these disks to be pressed



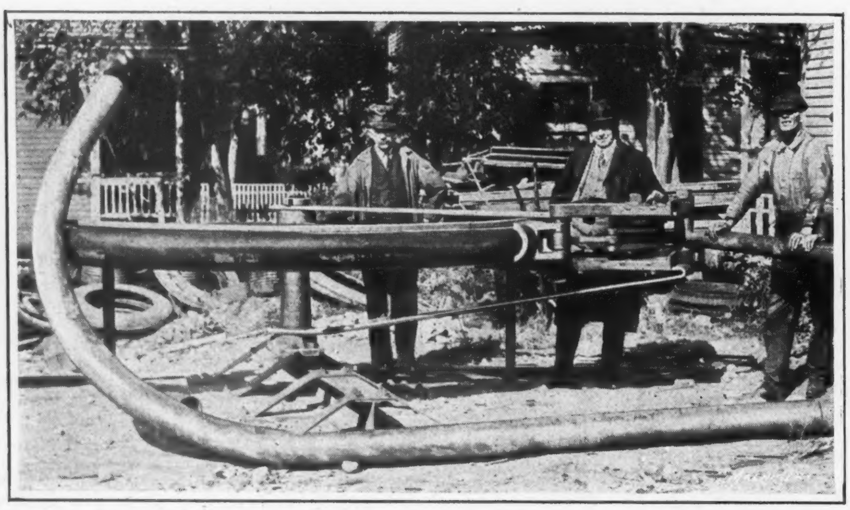
"Akron" Friction Clutch manufactured by the Williams Foundry & Machine Co.

into contact with the friction surfaces of drum *A* and cover *D* with tremendous force.

In working out the design of the shifter ring *U*, provision has been made for retaining oil and for excluding dust and dirt. The ring is made of cast iron and lined with babbitt metal. Adjustment of the clutch is accomplished by means of head *D* which, it will be seen, is screwed into drum *A* and provided with notches to receive the point of locating screw *C*. The pitch of this screw and the number of notches are so proportioned that an adjustment of one notch corresponds to a lateral movement of 0.005 inch between the friction surfaces. No attention need be given to the "Akron" clutch other than to occasionally renew the oil in the case, which is retained by cover *D*. The supply of oil is replenished through oil-hole *B*. By providing a large area for the friction surfaces, maximum power is provided with a minimum amount of wear on any of the parts. A volume of oil covers the friction surfaces and is not squeezed out until the opposing faces are revolving at nearly the same speed. As a result, the clutch takes the load gradually and this reduces wear to a surprisingly small amount. There are no extended parts of the clutch which may result in injury to the operator, and the clutch is of compact design, occupying a minimum amount of space.

AMERICAN PIPE-BENDING MACHINE

An equipment known as the "Wonder" pipe-bending machine is one of the recent products of the American Pipe Bending Machine Co., 37-39 Pearl St., Boston, Mass. The principal features of this machine are that it is said to do work of excellent quality without requiring the pipe to be heated; also, that the length of time involved in performing a pipe-bending operation is remarkably short. This will be appreciated by all men who have had experience in doing work of this kind, when it is learned that 90-degree bends have been made in 6-inch iron pipe in less than ten minutes.



"Wonder" Pipe-bending Machine built by the American Pipe Bending Machine Co.

SIDNEY SHELL TURNING LATHE

To facilitate the rapid production of Mark VIII 155-millimeter shells, the Sidney Machine Tool Co., Sidney, Ohio, has designed a single-purpose 25-inch lathe which has been developed by making the necessary modifications in the construction of the standard heavy-duty lathe of this company's manufacture. The shell lathe is designed without a lead-screw or provision for thread cutting, and is equipped with two toolposts and means of automatically turning the contour of the shells or other work to any predetermined shape. The functions of the toolposts, each on its independent slide, will be readily understood by referring to Fig. 2.

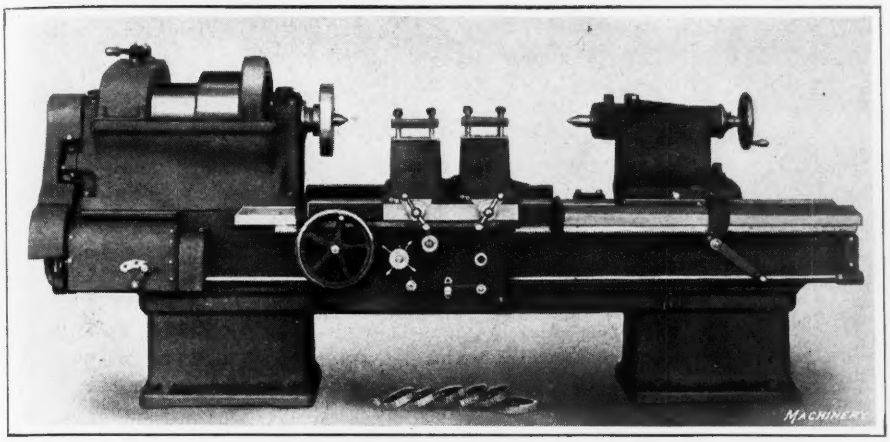


Fig. 1. Shell Turning Lathe made by the Sidney Machine Tool Co.

The left-hand slide is manually operated and the right-hand one is automatically controlled by the profile turning form or cam mounted at the rear of the lathe bed. The shape of this form can, of course, be varied to any required shape and on this account it seems probable that the machine will find application in other fields than the turning of shells. Attention is called to the fact that the form used on the machine is supplied by the user and is not part of the equipment regularly furnished.

This lathe is of the double back-geared, closed-head type. The spindle is made of a 50-point carbon crucible steel forging, accurately finished and carried in bronze bushed bearings at both the front and rear end, with the thrust taken on collars. In a preliminary test for production, the machine is said to have completed the turning of a 155-millimeter shell in two minutes, taking a roughing and a finishing cut. All of the gears in the apron are made of steel, and the feed-box is provided with high-carbon steel gears. The tailstock has an extra long bearing on the bed, and the carriage has a bearing 35 inches in length. Other principal dimensions of the lathe are as follows: Swing over shears, 27½ inches; distance between centers, 4 feet 6 inches; length of bed, 10 feet; and approximate weight of machine, 7000 pounds.

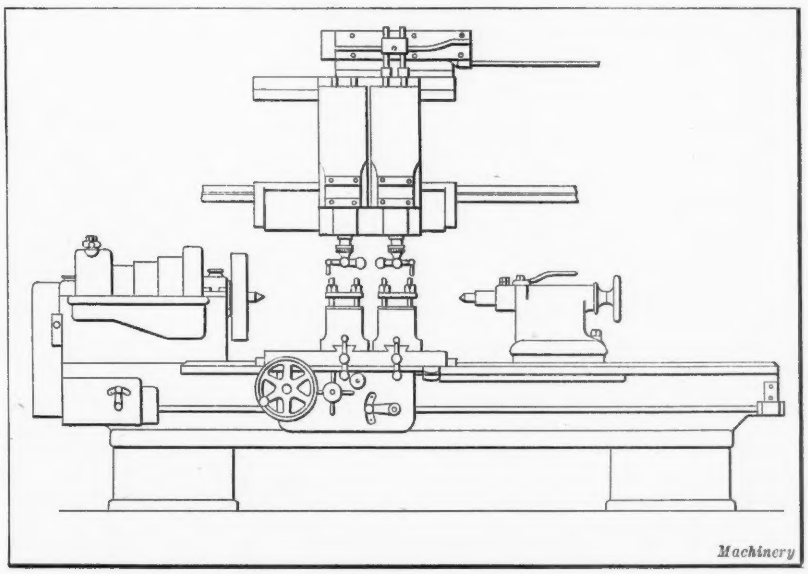
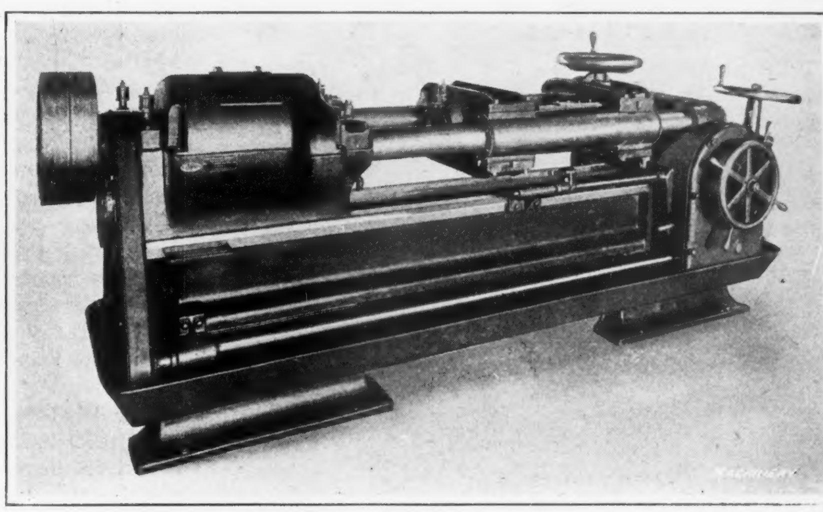


Fig. 2. Plan and Front Views of Sidney Shell Turning Lathe showing Arrangement of Profile Turning Attachment

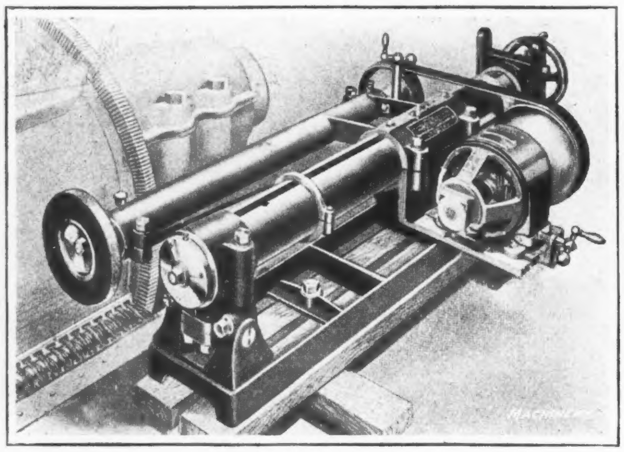
REED-PRENTICE DUPLEX BORING MACHINE

This specialized machine was designed for boring the cylinders of Liberty motors. In the several months that they have been in operation they have accomplished more than was expected of them in the rapid removal of metal accurately. The head unit is very rigid and contains a herring-bone gear reduction. The bearings are bronze-bushed with sight-feed oilers. The spindle is hardened and ground on all bearing surfaces. All gearing is entirely guarded with hand-hole covers at proper points for inspection. The drive is by a single pulley, 18 by 6½ inches in size, and gives but one spindle speed. For other classes of work the gearing would have to be redesigned for the work to be performed. The feed is positive gear driven through a single train and is designed for the class of work at hand.

In the apron the feed is by means of a worm with approximately a 100 to 1 reduction. There is a positive and automatic knockout to the power feed. There is also an auxiliary worm which can be thrown in when it is desired to use the handwheel feed for rapid movement of the carriage. The carriage shown in the illustration is of special design to hold a Liberty motor cylinder. This is arranged with a quick-acting clamp which centralizes the cylinder and holds it securely for the boring operation. When the proper depth has been reached the carriage feed is automatically tripped and the feed stopped. The carriage is supported on two extremely large, heavy ground bars instead of on the bed as is the usual practice. This is to give direct support in line of pressure when the machine is in operation and prevent any distortion of the bed. The end pressure while boring is tremendous, and this is all taken up by tension in the bars with little or no strain on the bed. The bed has been made extra deep, wide, and well braced, with ties to give the machine a rigid foundation. An oil-pan is provided for the cutting compound. This machine, as will be understood from the preceding description, can, by slight changes in design of gearing, etc., be made to accommodate most boring operations. Its power and speed recommend it wherever a large quantity of like pieces must be bored accurately and quickly. This machine is a recent product of the Reed-Prentice Co., Worcester, Mass.



Reed-Prentice Double Bar Boring Machine for Liberty Motor Cylinders



Electrically Driven Commutator Grinder built by the Shafer-Decker Co.

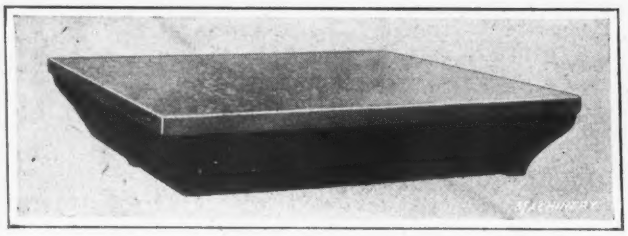
SHAFER-DECKER COMMUTATOR GRINDER

In order for an electric generator or motor to operate efficiently, it is important for the surface of the commutator to be kept in good condition. Attention paid to this point will often result in a substantial increase in operating efficiency. To provide for doing this work, the Shafer-Decker Co., 15 Circle St., Rochester, N. Y., is building a universal commutator grinder which is shown in the accompanying illustration. It is claimed that the use of this machine will save considerable time and expense, and as the work can be done quickly it insures being able to have the electric generator or motor ready for use with very little delay. In many cases, this factor will be of absolute importance, because shutting down of the electrical apparatus means a serious, if not a prohibitive, amount of lost time and inconvenience. The way in which the grinding wheel is applied to the commutator is clearly shown. This is a Type 30 machine, with a capacity for finishing commutators up to 30 inches in length.

A special grinding wheel is used which is made of a combination of materials that avoids clogging the abrasive cutting surface with particles of copper or mica. It will be seen that independent motor drive is employed, a one-horsepower motor being required for this purpose. The grinding wheel is perfectly balanced so that it may be driven at 6000 revolutions per minute. Two wheels are commonly used—a coarse-grained wheel for reducing the commutators to a true surface and a fine wheel for obtaining the required perfection of finish. A particularly important feature of the machine is its portability, making it possible for the grinder, which weighs only 600 pounds, to be adjusted in position for grinding a commutator of any diameter and up to 30 inches in length, so that the work may be done on generators, rotary converters, or motors without requiring the machine to be disassembled.

SIMPLEX BENCH PLATE

In the accompanying illustration is shown a bench surface plate which has recently been placed on the market by the Simplex Tool Co., Woonsocket, R. I. This plate is of a size which adapts it for use on a bench in laying out or inspecting machine parts and special tools, according to the usual method of procedure in handling work of this nature. It is well ribbed to assure having the plate hold its shape and original accuracy. Two sizes of plates are made, namely, 12 by 14 inches and 20 by 30 inches, and these may be finished with either a planed or scraped surface.

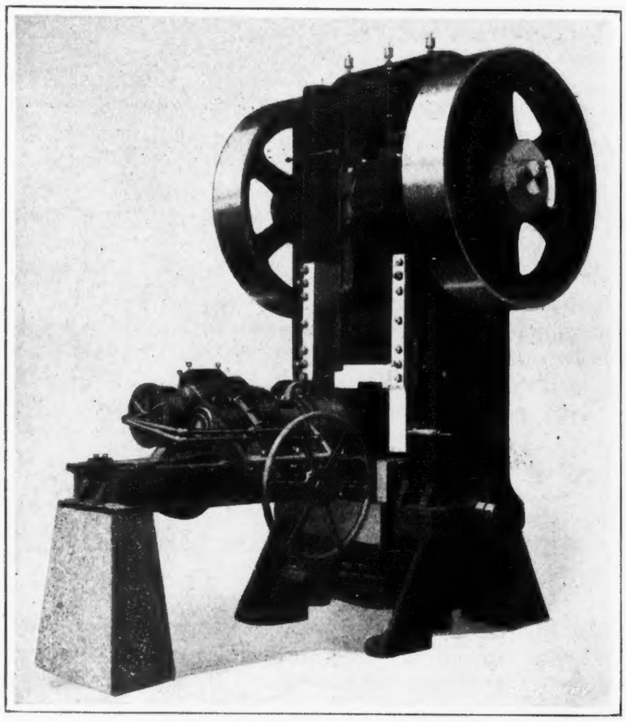


Bench Surface Plate made by the Simplex Tool Co.

TOLEDO NOSING PRESS

To provide for performing the nosing or pointing operation on the open end of high-explosive shell forgings, the Toledo Machine & Tool Co., Toledo, Ohio, is now building a No. 59 straight-column press which is shown in the accompanying illustration equipped with twin flywheels and a feeding-in attachment. The capacity of this press is largely governed by the heating facilities which are available in the plant, but the actual nosing operation requires about forty seconds; hence, the heating operation is the limiting factor in determining the productive capacity of machines of this type. If a satisfactory continuous heating furnace were developed, the output of nosing departments equipped with machines of this type would be substantially increased.

It will be seen that the press frame is of the Toledo four-piece steel tie-rod type of construction, consisting of a base, two uprights, and a crown, which are held together by four steel tie-rods that are shrunk into place. These tie-rods carry the tension load, and the uprights are designed with ample capacity to support any lateral stresses which may be imposed upon them. The shafts are of the eccentric type and are made of hammer forged steel of special analysis to give exactly the desired physical properties. They run in bronze-bushed bearings. Adjustment of the connections is obtained by means of a wedge in the bed. The flywheels are keyed directly to the shaft, and no clutch is necessary, as the press runs continuously at high speed. A forced-feed lubrication system is furnished, which is operated by grease guns within easy reach of the operator.



Straight-column Nosing Press built by the Toledo Machine & Tool Co.

A feeding-in attachment of the type most commonly furnished with this nosing press is shown in the illustration. With an attachment of this kind, the machine is said to provide for closing in an absolutely uniform and concentric nose on the shell. The inside surface of the nose is free from ripples and is true with the body of the shell. After the open end of the forging has been heated to a cherry red, the shell is held in an air-operated collet chuck and fed into the dies by means of a large pilot wheel, being rotated at a variable increased speed until it is closed in. Machines of this type are made with capacities for nosing shells up to 6, 8½, and 12 inches in diameter, respectively.

CONTINENTAL ASSEMBLING AND WELDING TABLE

For use in the performance of assembling, inspection, riveting, welding, and similar operations, the Continental Auto Parts Co., Knightstown, Ind., has placed on the market a table on which it is said that work of this kind may be done under the most advantageous conditions. It is not necessary to lift the work off the table in order to get at the various parts, as the table may be merely unlocked and turned to the desired position where the best light may be obtained. This possibility of saving time and labor is responsible for a substantial speeding up of production. Vises and various types of work-holding fixtures may be clamped directly to the table to adapt it for any required use. For instance, by mounting two or more fixtures around the circumference of the table, provision may be made for the continuous performance of drilling operations, because the finished work may be removed from one fixture and a new blank substituted while the drilling operation is being performed on work held in the other fixture, which is only one of the numerous ways that an outfit of this kind may be advantageously employed.

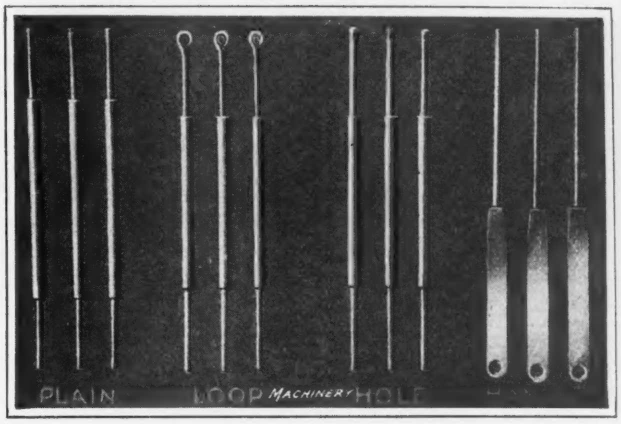
This table is substantially constructed with heavy reinforcements to afford the necessary strength, rigidity, and

Table built by the Continental Auto Parts Co. on which Assembling and Similar Operations can be advantageously performed

durability. It revolves on ball bearings, and the top is finished to make it suitable for the performance of laying-out and inspection operations. Thirty-six locking positions are provided so that the table may be turned as required on the sensitive ball bearings, and then locked by moving the foot-treadle which controls the bolt. Tables of this size are made in two models known as Nos. 24 and 32. The principal dimensions of the No. 24 table are: Height, 32 inches; diameter of table, 24 inches; size of base, 16 by 20 inches; and approximate weight, 320 pounds. For the No. 32 table, the principal dimensions are: Height, 32 inches; diameter of table, 32 inches; size of base, 16 by 20 inches; and approximate weight, 425 pounds. The table tops are interchangeable, so that two tops can be furnished for use on a single pedestal.

FORTNEY MEASURING WIRES

The Fortney Mfg. Co., 13-15 Franklin St., Newark, N. J., has recently placed on the market a full line of thread gage measuring wires which are generally made in four different

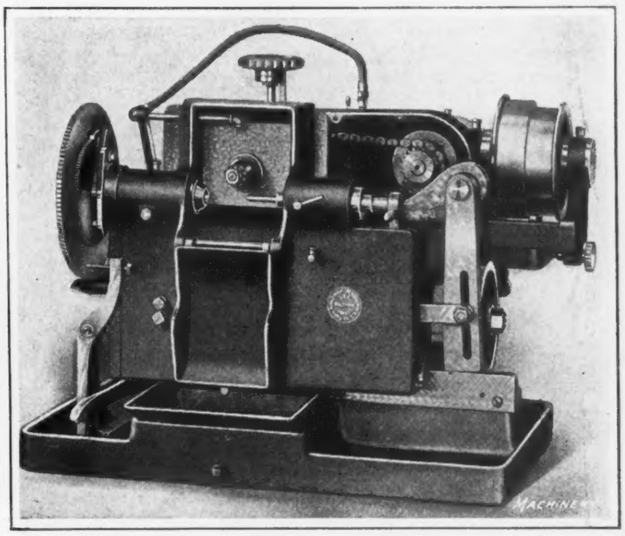


Thread Gage Measuring Wires made by the Fortney Mfg. Co.

styles; namely, plain, loop, hole, and handle. The plain wires are for use when measuring thread gages with a micrometer; and the other styles are intended for use with special machines for measuring the pitch diameter by the three-wire system. These wires are made in any required size, ranging from 0.010 to 0.250 inch in diameter, and are said to be accurate to 0.00005 inch. Specially prepared steel is used, which is hardened by a process that gives the desired physical properties to the wires.

WALTHAM FOUR-INCH SPUR-GEAR CUTTING MACHINE

The Waltham Machine Works, Waltham, Mass., have recently made a number of improvements in the 4-inch gear-cutting machine which they manufacture, and the following is an outline of some of the more important changes. Power for the speeds and feeds, indexing of the work, and operation of the geared pump is obtained from a shaft carrying a two-step cone pulley, which may be driven from either a wall or ceiling type of countershaft or by means of an individual motor. Ball bearings are used in all parts of the driving mechanism, except to carry the main camshaft, cutter-spindle, and work-spindle. The cutter-spindle is driven by a silent chain and sprockets which are interchangeable in position, so that in connection with a two-step cone pulley four changes of speed are available. A one-revolution camshaft controls the indexing mechanism, and this is inoperative while the cut is being taken. During the process of indexing, the pawl is held clear of the index and is allowed to drop into place only when the index notch reaches the desired position. During the cutting operation, the cutter-slide is securely clamped, the clamp being released and the slide lifted during the return of the work-slide and the



Waltham 4-inch Spur-gear Cutting Machine with Covers removed to show Mechanism

indexing of the work. The machine may be stopped after the last cut, with the cutter lifted, where it is in the best position for the insertion of a new blank, by an automatic adjustable brake on the driving cone pulley. During the operation of cutting, the work is completely enclosed, thus protecting all working parts of the machine.

The principal dimensions of this machine are as follows: Maximum pitch diameter of work that can be cut, 4 inches; coarsest pitch of teeth that can be cut, 16; speed of countershaft, 675 revolutions per minute; diameter of tight and loose pulleys, 6 inches; width of driving belt, 2 inches; dimensions of pan base, 28 by 18 inches; diameter of cutter-arbor, ½ inch; standard dimensions of cutter, 1¼ inch in diameter by 0.20 inch thick, with arbor hole ½ inch in diameter; largest cutter that can be used to obtain full capacity of machine, 1⅜ inch in diameter; diameter of index plate, 10 inches; standard number of divisions in index, 120; number of spaces that can be obtained with a 120-index, 8, 10, 12, 15, 20, 24, 30, 40, 60, and 120; No. 1 work-slide cam will cut strokes between 0.5 and 0.8 inch; No. 2 cam, from 1.1 to 1.75 inch; No. 3 cam, from 1.87 to 3 inches (the No. 3 cam is regularly furnished, and Nos. 1 and 2 cams may be furnished as extra equipment); weight of machine, 610 pounds.

LANGELIER DUPLEX SHELL ADAPTER MILLING MACHINE

The machine shown in Figs. 1 and 2, which is made by the Langelier Mfg. Co., Arlington, Cranston, R. I., is used

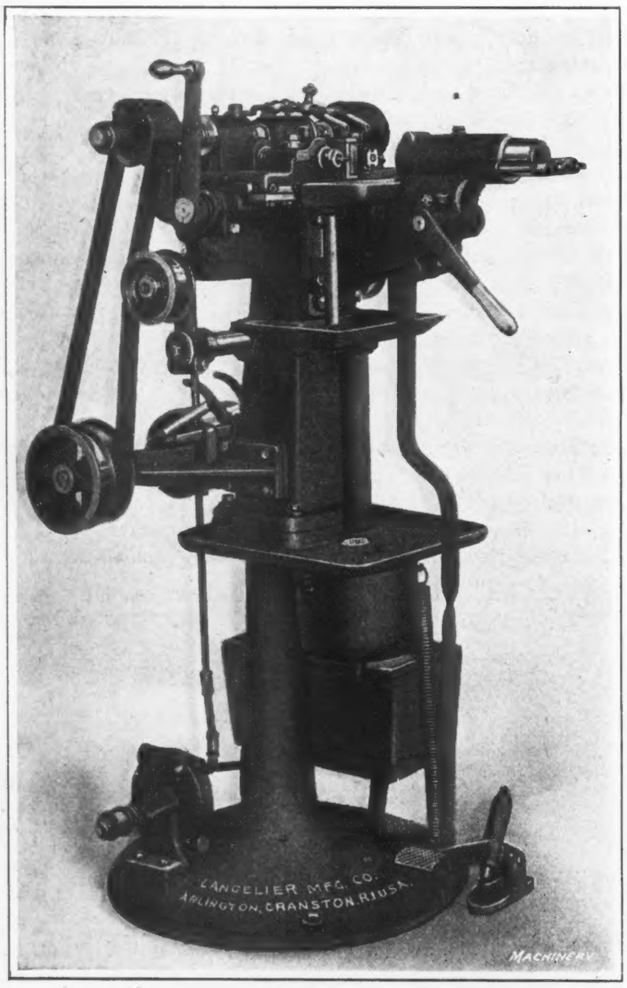


Fig. 1. Langelier Duplex Machine for milling Wrench Slots in Shell Adapters

for milling simultaneously the two wrench slots in 155 millimeter Mark I combination steel shell adapters shown in Fig. 3. The end-mills are ⅜ inch in diameter and run at 750 revolutions per minute. The output is twelve adapters per minute. This machine has two milling heads mounted

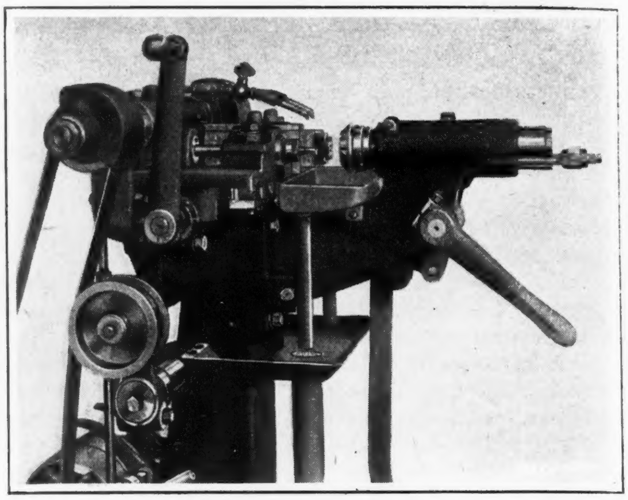


Fig. 2. Close View of Mechanism of Langelier Duplex Milling Machine shown in Fig. 1

on a T-slide that runs crosswise to the axis of the spindles. These milling heads are fed simultaneously toward each other by a hand-lever that is attached to a right and left Acme threaded shaft located lengthwise in the slide. The rear gibs on the milling heads have projecting lugs that engage the threaded portions of the shaft; and at the right-hand end of the feed-shaft, an adjustment is provided for locating the milling heads in their correct working positions. An adjustable stop-screw on the hand-lever determines the amount of feed.

The milling spindles run in phosphor-bronze bushed bearings. They are adjustable axially for locating the spindles in their milling positions. Ball bearing thrusts are used on the spindles. The end-mills have No. 1 Morse taper shanks and the spindles are provided with a lock-nut arrangement that holds the mills positively and also makes it easy to remove them. The spindles are driven by spiral gears that are encased and run in oil. These spiral gear drives and milling spindles are combined in a unit in the milling heads, and each unit is driven by an independent belt drive. By this arrangement the milling heads are not affected by the belt pull.

The main drive for the milling heads is obtained from a countershaft attached to the standard. This countershaft has tight and loose pulleys and is driven from overhead, the belt drive for each milling head being provided with a belt tightener pulley. The mechanism for holding and locating the adapter, Fig. 3, while the notches are being milled consists of a locating head fastened to the slide midway between the milling heads. The head has a self-acting spring plunger, and also an adjustable stop for determining the travel of the plunger. The plunger has a pilot on its front end that enters the counterbored hole in the adapter.

Acting in conjunction with the locating head there is an internal, expanding-chuck spindle mounted in line with the locating head in a bracket that is attached to the front of the machine. In Fig. 2 the chuck spindle is shown in the outer or chuck-

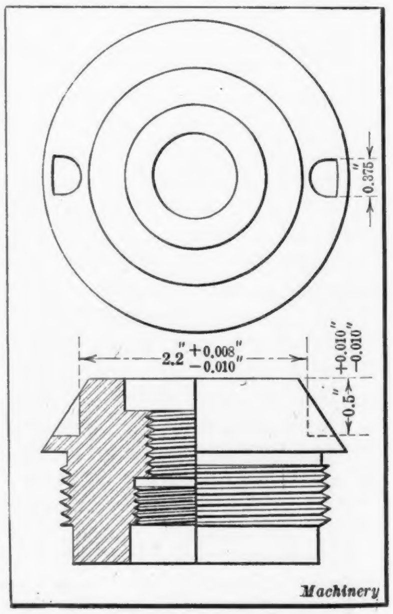


Fig. 3. Mark I Adapter in which Slots are milled

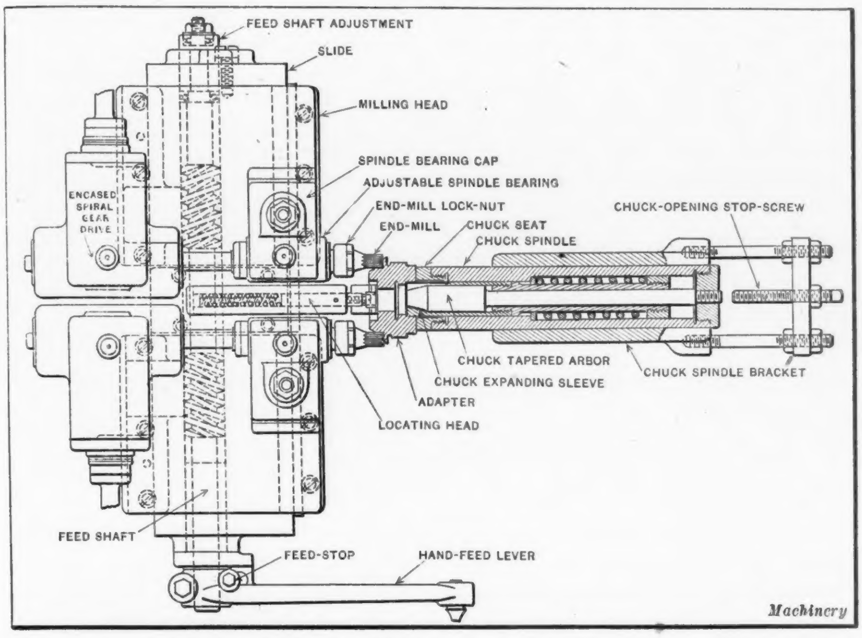


Fig. 4. Langelier Duplex Adapter Slot Milling Machine with Chuck Spindle in Milling Position

ing position and in Fig. 4 in its milling position. The chuck consists of a spring-operated split sleeve sliding upon a statonary taper-end arbor that is anchored at the outer end of the spindle. The split sleeve projects about ¼ inch in front of a hardened seat on the inner end of the spindle. The chuck is opened or closed by the hand-lever at the left side of the bracket, when the spindle is in its outer or chucking position, and. also an adjustable stop for determining the travel of the plunger.

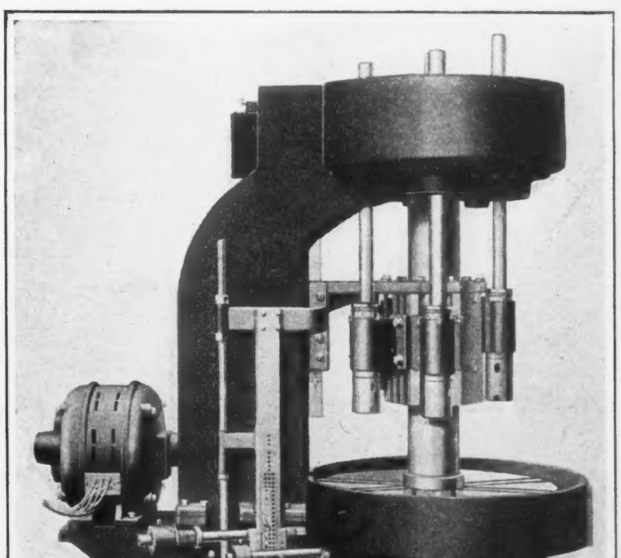
The spindle, with the adapter chucked on its inner end, is advanced to its milling position by the foot-lever acting in combination with a toggle lock. The chuck has a drawing-in action which insures the adapter seating accurately. A removable chip and oil guard (not shown) is used to protect the milling heads. An automatic cutting oil supply is provided, and also an automatic shut-off for delivering oil only when the mills are cutting. This machine occupies a floor space of 30 inches by 32 inches and is 4 feet 6 inches high. The net weight is 660 pounds.

MCDONOUGH AUTOMATIC MULTIPLE-SPINDLE CHUCKING MACHINE

With labor costs steadily mounting and maximum production becoming increasingly essential, manufacturers are turning more and more to the use of automatic machinery to relieve these pressing conditions. The new Daniels automatic multiple-spindle chucking machine, here illustrated, has just been placed on the market by the McDonough Mfg. Co., Eau Claire, Wis. This machine was designed by Lee G. Daniels and David Sundstrand, both of Rockford, Ill. It is said to be the only machine of its kind, being constructed on a new principle. This machine is built to afford an efficient means of machining parts in large quantities, and to use unskilled labor to operate the machine after it is set up and timed. It handles work from 3 to 6 inches in diameter, performing the following operations: Cup turning, drilling, boring, reaming, facing, tapping with collapsible taps, and drilling multiple offset holes by means of attaching a multiple-spindle auxiliary head to any of the spindles.

The machine has five tool-carrying spindles and a blank station. The turret, upon which the spindles are mounted and which has its axis concentric with that of the table, does not revolve but through its automatically controlled vertical movement, it feeds the tools to the work. After the spindles perform their different operations, a finished piece is removed when it is at the "blank" station and an unmachined part replaces it. The time of machining a piece is the time of the longest operation plus the time of one indexing. The table has six chucking positions and revolves step by step, bringing each chucking position successively in alignment with each spindle. On one machine now in operation, finished pieces are turned out at the rate of one every two minutes. It is stated that three machines, which were previously required for machining the parts, have been eliminated and three skilled operators released for other work. Thus one unskilled worker, with the Daniels machine, can do the work of three or more machines and a like number of operators on this particular operation. The Daniels automatic multiple-spindle chucking machine has a far greater output than a single-spindle machine, because several pieces of work are being operated upon simultaneously and the operator is, at the same time, taking out a finished piece and chucking a new one.

The spindles have a rapid approach to and a rapid reverse from the work. The spindle carrier is operated by means of a quadruple screw operating through a bronze nut in the center column. This screw is revolved by means of a worm and gear and three friction clutches, one for a rapid approach, one for the feed, and one for a rapid reverse. In obtaining these movements through friction clutches, the machine is protected because if a tool should break and jam in the work, the feed pressure would go up and cause the feed friction to slip, thus automatically protecting the mechanism. If in the movements of rapid approach, reverse, or indexing of the table, any of these should jam, their friction clutches would slip before damage could be done to parts of the mechanism. The machine is operated by two levers, so placed that they are always in reach of the operator, from the chucking positions. The table is 36 inches



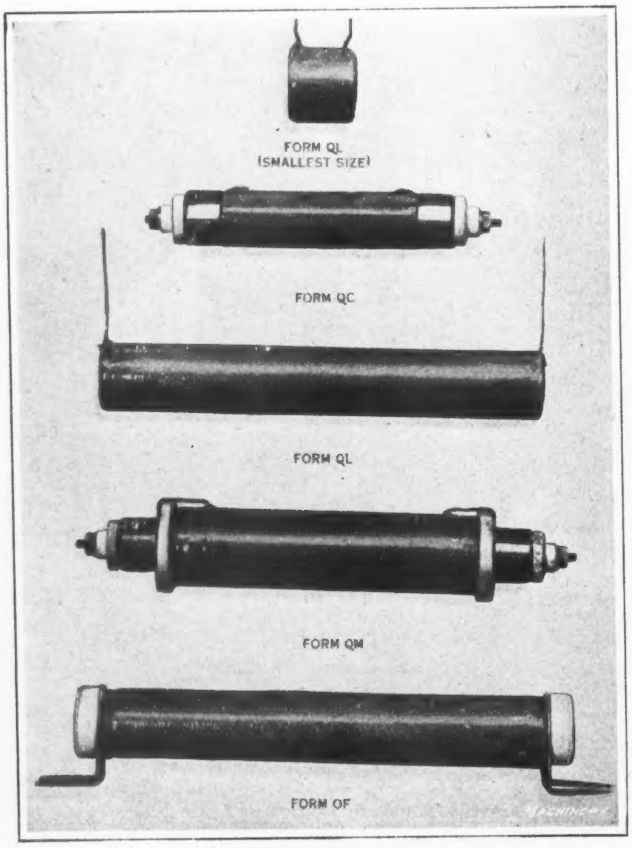
Daniels Automatic Multiple-spindle Chucking Machine built by the McDonough Mfg. Co.

in diameter and six 10-inch chucks or work-holders can be mounted. The chucks and tools on the spindles will vary in size and design to fit the requirements of the particular work to be done. The travel of the spindle carrier is 13 inches and it takes 4 inches of this movement to withdraw the locating pin and to control the indexing of the table. The table can be set to index one, two, or three spaces, depending upon the operations required. The speeds are varied by means of change-gears and there is one set that controls the speed of all the spindles and each spindle has an individual set of change-gears, so that each can be given the most efficient speed for any particular operation.

GENERAL ELECTRIC ENAMELED RESISTANCE UNITS

Enameled resistance units for regulating current have been developed in various forms and sizes by the General Electric Co., Schenectady, N. Y. Some of the applications to which these units have been put are railway and fire alarm signals, fractional horsepower motors, and locomotive head lights. They are also used extensively in series with relay, contactor, and circuit breaker coils on panels and switchboards. These resistance units will be found particularly applicable in mines and similar places where the atmosphere is damp. They are unique in their ability to withstand unusually high temperatures as well as sudden changes in temperature from one extreme to the other.

The resistance wire or conductor is wound either upon a steel body coated with a special refractory enamel or paint and high heat-resisting silicate compound developed to withstand sudden extreme temperature changes without cracking or weakening, or in any way being injured. The steel body is preferred for extreme lengths where strength for a long span is required and is especially serviceable where the unit might be subjected to severe vibration or shock. The refractory silicate body is used for most of the ordinary types of resistance. The compound employed is far superior to porcelain or any equivalent ceramic products which are easily cracked or weakened mechanically by repeated and extreme temperature fluctuations.

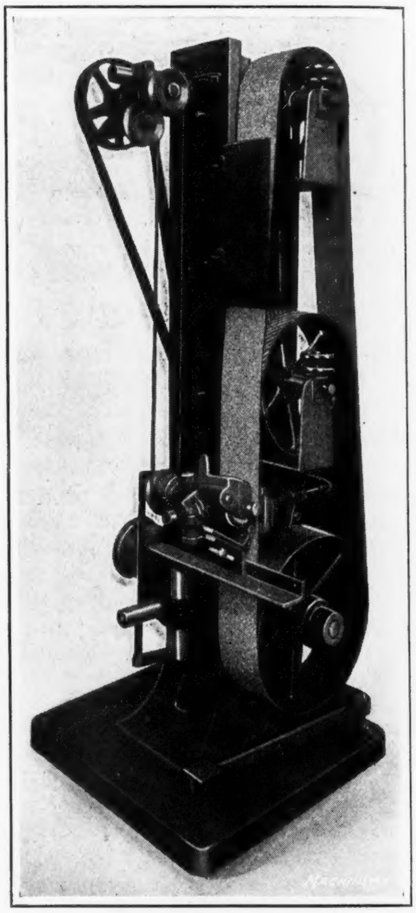


General Electric Enameled Resistance Units for Electric Current Regulation

After being wound upon the proper body, the conductor is embedded in a blue vitreous enamel and is fused until it has a uniform glossy structure at a temperature of about 1000 degrees C. This enamel is moisture and heat resisting and forms a mechanically strong casing for the conductor. Enamels of the type used are extremely durable and maintain their dielectric strength and mechanical properties indefinitely. Several different methods of attachment to the circuit have been developed as shown in the accompanying illustration. A variety of units of various sizes and ohmic capacities have been standardized and units of a special nature are obtainable.

BLEVNEY VERTICAL ABRASIVE FINISHING MACHINE

This machine embodies the Blevney two-belt system of finishing with an abrasive cloth belt running at high speed over a heavy corrugated leather cushion belt. Without a mechanical holding device or power feed attachment, the work is held by hand, yet the possible rate of production is said to be very satisfactory, and the finish produced on the work is of a superior nature. With a mechanical holding device and power feed attachment the machine becomes automatic in operation and the production is limited only by the ability of the operator to handle the work. Skilled labor is not necessary for the operation of these machines.



Vertical Abrasive Belt Finishing Machine built by the Blevney Machine Co.

The type A machine is built up on a heavy cast-iron column providing the necessary rigidity for a high-speed machine. Steel ways are attached to the column, and the sliding frames in which the idler pulleys operate travel on these ways. The main pulley rests in suitable boxes in the lower part of the main column and the driving pulley is attached to the other end of the shaft. The cushion belt is run over the main pulley and the idler next above it, traveling at a speed of 7000 feet per minute. The cloth abrasive finishing belt is placed over the cushion belt, running from the main pulley to another idler pulley operating in the frame on top of the machine. These idler pulley frames in both cases are governed by weighted levers, having a fulcrum journaled wheel and steel pinion connection with a steel rack attached to the frame. The weighted levers should be in a horizontal position when the machine is in operation and to bring the levers to this position a spring is provided holding the pinions in engagement with the rack. By pulling the fulcrum against the action of this spring, the pinion will become disengaged and the lever may be moved to any desired position, the spring restoring the engagement be-

tween pinion and rack. The alignment of the two belts may be controlled by means of handwheels operating on the idler pulley boxes, these wheels serving to tilt the pulleys so that the position of the belts may be changed as desired.

A suitable stock rest is provided for holding the stock and for the application of fixtures and attachments. A spring platen or pressure bar is applied back of the cushion and finishing belts. The action of this pressure platen is controlled by a foot-treadle and stops are furnished to limit the forward and return movement of this platen. The face of the platen is made to suit the work to be finished. Thus, for plain flat work the platen has a plain face. For finishing tubes or round pieces, parallel strips are placed at the top and bottom of the platen, causing the belt to curve around the circumference of the stock that is being finished. In this way the belt adapts itself to the contour of the work and produces the desired finish. Where desired, the platen may be made sectional at a slight additional cost, or special rotating platens with yielding centers can be furnished.

Fig. 1. "Testall" Machine built by Charles Eisler

The new power feed mechanism applied to this machine merits special consideration. The feed-roll is mounted on a stud giving it a swivel action. It also has a provision for tilting and when tilted to the left, feeds forward; to the right, feeds reverse; when in a level position the feed is neutral or there is no feed at all. These provisions adapt the machine for performing a variety of finishing operations which would be very difficult of attainment otherwise, such as the finishing of tap shanks which are dropped into place with the feed-roll neutral, finished, and then, with the roll reversed, fed out of the machine into a receptacle in which they are taken away.

A quick-change platen is another new feature of the machine. The adjustment on this pressure platen may be quickly changed by a hand nut conveniently located for the purpose. The platen plate is also quickly removable and no tools are required for the change. It is simply lifted from its socket and substituted with a duplicate of the required form. All work finished by the Blevney two-belt system may be held stationary or fed past the belts while the belts are brought to the work with a predetermined pressure. The power feed attachment will accommodate round stock from 1/4 inch to 2 inches in diameter, or larger if made special. The capacity for hand work is anything within range of the belt and the holding ability of the operator. This is a recent addition to the line of abrasive belt finishing machines manufactured by the Blevney Machine Co., Greenfield, Mass.

EISLER "TESTALL"

For use in rapidly and accurately testing the concentricity of various types of gears and similar work, the uniformity of the distance between a rack and pinion, the accuracy of the throw of cams, and for a great variety of similar purposes, Charles Eisler, 36 Watsessing Ave., Bloomfield, N. J., has recently placed on the market a machine known as the "Testall." This machine is shown in Fig. 1, and Figs. 2 and 3 show various applications from which a good idea will be obtained of the different purposes for which a machine of this kind can be employed. Attention is called to the fact that this testing equipment has been especially developed for use in determining the accuracy of production work, and on this account the design has been worked out in such a way that successive pieces of duplicate dimensions may be set up and the accuracy of their dimensions ascertained with a minimum expenditure of time.

The Eisler "Testall" was originally developed for use in determining the accuracy of center distances for different types of gears and similar classes of work. From Fig. 1 it will be seen that a stand is provided which holds the machine at a convenient height from the floor so that the setting up and testing may be conveniently accomplished. A drawer is provided under the stand in which wrenches, mandrels, and attachments can be kept when not in use. Experienced mechanics will at once see the possibility of employing this machine for various other purposes beside testing those products which have been specifically mentioned; in addition, a machine of this type may be advantageously employed for laying out work.

At the base of the machine there will be seen three types of mandrels lying between the spanner wrenches and the auxiliary supporting fixture. These mandrels are accurately ground, and the user of the machine provides bushings of the proper sizes for the work which he has to support, these bushings being ground to the mandrel diameter on the inside, while the outside diameter is ground to fit the bore of the work. It will be apparent from the illustrations Figs. 2 and 3 that in all cases the supporting fixtures do not have to be changed in removing one piece of work and substituting the next similar part to be tested. This feature of keeping the supports fixed and simply withdrawing the mandrel or other member of like nature, when changing the work, is the means of adding greatly to the rapidity with which tests can be made. Various wearing parts of this

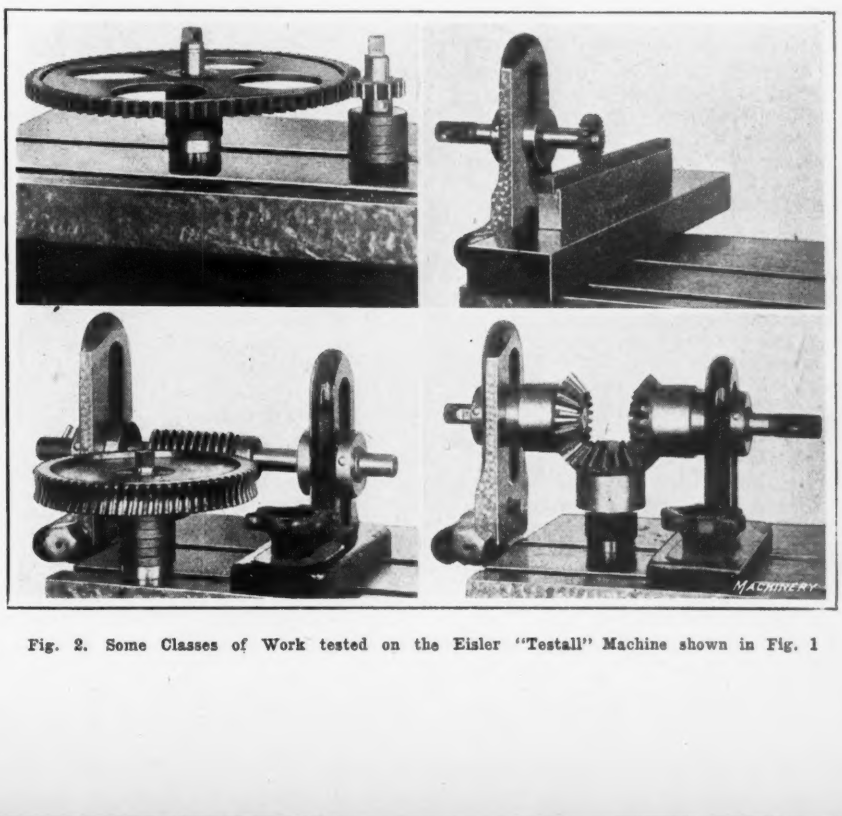


Fig. 2. Some Classes of Work tested on the Eisler "Testall" Machine shown in Fig. 1

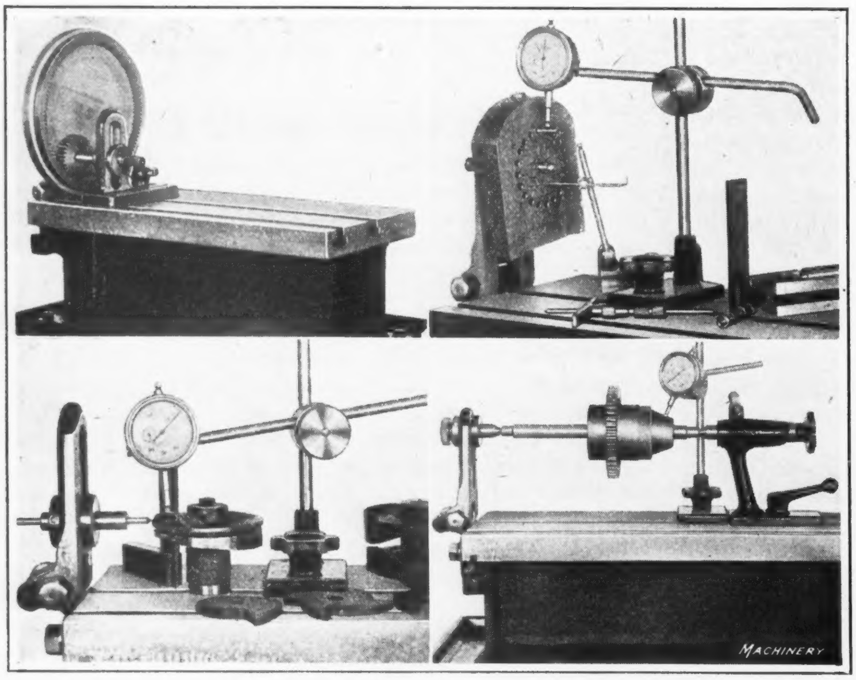


Fig. 3. Other Classes of Work tested on the Eisler "Testall" Machine

equipment are made of tool steel, hardened and ground, and the bed of the machine is carefully scraped to insure accuracy.

The Eisler "Testall" is made in two sizes known as Nos. 1 and 2. The No. 1 equipment is adapted for use on medium-sized work, and it is furnished with the complete equipment shown in Fig. 1. The floor space occupied is 16 by 22 inches; total height, 44 inches; size of table, 7½ by 17½ inches; and weight, 160 pounds. The No. 2 machine is suitable for testing work of double the size that can be set up on the No. 1 "Testall." A B. C. Ames dial indicator is part of the regular equipment of each of these outfits.

NEW MACHINERY AND TOOLS NOTES

Plain Milling Machine: Kempsmith Mfg. Co., Milwaukee, Wis. A No. 4 knee type milling machine which is known as the "Maximiller." It is a plain, horizontal, all-geared machine which is designed to provide for rapidly handling any class of work coming within the range of a machine of this size.

Portable Arc Welding Machine: Lincoln Electric Co., Cleveland, Ohio. A portable arc welding machine in which a gasoline engine is provided to drive the electric generator. This equipment was especially designed for use in shipbuilding plants, but it is also well adapted for such work as the construction of oil-pipe lines and similar purposes.

Centering Machine: Middletown Firearms & Specialty Co., Inc., Middletown, Conn. A machine which is adapted for the performance of centering operations on either round, square, or octagonal shaped stock. It is claimed that the machine will center within 0.001 inch of the true center of the work. Two speeds are provided which are suitable for use when the machine is working on hard and soft material.

Shell Boring Lathe: A. R. Williams Machinery & Supply Corporation, Fidelity Bldg., Buffalo, N. Y. A machine known as the "Galloway" shell boring lathe which is especially adapted for machining 155-millimeter and 6-inch shells. The bed is made of cast iron and provided with cross ribs. The head spindle has a capacity for taking shells up to 6 inches in diameter, and the work is held by a draw-collet equipment. The machine swings 32 inches over the bed.

Burnishing Cones: Abbott Ball Co., Elmwood, Hartford, Conn. A new style of burnishing material known as "burnishing cones," which are intended for use in tumbling barrels to provide for getting into small crevices on the work. The form of these cones consists of two conical points with the bases of the cones in contact and a sharp-edged rib running around the equator. Thus there are two points and the edge, all of which are effective in reaching relatively inaccessible points on the work.

Precision Grinding Machine: William O. Barnes, Leominster, Mass. A No. 78 precision grinding machine which is especially adapted for grinding complicated gang milling cutters. The machine may be used for this purpose regardless of whether the cutters have straight, spiral, radial, or under-cut teeth. The entire gang may be completely ground at a single setting, and exactly the proper clearance is provided on all of the side teeth, as well as those teeth situated on the periphery of the cutters.

Milling Vise: Edlund Machinery Co., Cortland, N. Y. A vise fitted with side bars which carry the clamping strain. The manufacturers claim that this construction enables the stationary jaw to remain square with other members of the vise, regardless of how much pressure is applied on the screw. A cam provides for moving the sliding jaw away from the work when the bars are raised and for advancing this jaw toward the work when the bars are lowered. Final clamping is accomplished by the screw.

Sensitive Drilling Machine: Edlund Machinery Co., Inc., Cortland, N. Y. A high-duty sensitive drilling machine in which the frame is of one-piece construction, with an inverted U-shaped casting, connected by a tie-rod at the lower ends, to support the spindle. This machine has a clearance of 21 inches from the table to the spindle and it drills to the center of an 18-inch circle. Owing to its rigid construction, it is stated that this machine operates with very little trouble from breaking small drills.

Lapping Machine: B. L. Schmidt Co., Davenport, Iowa. This outfit was especially designed and built for use in lapping the tappet arms of gasoline engines, but it may be adapted for many similar classes of work. There are twelve spindles which are automatically raised and lowered by cams and as the spindles rotate, the fixtures which have a reciprocating movement, receive the tappets which are loaded while the machine is running. Four of the fixtures are loaded while the other eight are in operation.

Time Recorder: Sinograph Co., Inc., 412 Eighth Ave., New York City. An autographic recording device which is suitable for use in shops or offices where the number of persons for each recorder does not exceed fifty. The person registering signs his name through a small window at the front of the instrument, which is nominally closed by a metallic frame containing a celluloid window that shows the name of the last person who signs the record. The paper is then moved by turning a knob at the side of the machine.

Sand Blast for Shells: Pangborn Corporation, Hagerstown, Md. An automatic shell cleaning equipment which is adapted for the continuous sand-blasting of 155-millimeter shells. There are four rotating chucks in the cabinet which revolve at slow speed on dustproof bearings. A direct high-pressure sand-blast machine with two lines of hose feeds two nozzles that are so located as to project within the shell openings of alternate shells, so that two are cleaned while the other two chucks are being unloaded and provided with fresh work.

Safety First Crane Panel: Cutler-Hammer Mfg. Co., Milwaukee, Wis. In order to provide as far as possible for the safety of operators, this company has developed an apparatus panel for cranes which is provided with special safeguards. This equipment is designed for use with either direct or alternating-current motors, ranging in sizes from 50 to 400 horsepower, where manually operated controllers are employed. The panel takes the place of various circuit breakers, knife switches, fuses, etc., mounted on an open switchboard in the crane cab.

Planetary Thread Milling Machine: Hall Gas Engine Co., Bridesburg, Philadelphia, Pa. A planetary thread milling machine which is especially adapted for the performance of those threading operations which are involved in the production of various types of shrapnel and high-explosive shells. As its name implies the milling cutter on this machine moves around inside of the work which is held stationary at all times. The claim made for this system of thread milling is that it provides for cutting more accurate threads and also enables the work to be done at higher speed.

* * *

The government plans call for an addition to the daily output of approximately 80,000 75-millimeter, 35,000 155-millimeter, and 1500 240-millimeter high-explosive shells; also, for the erection of a plant that will produce daily 5000 155-millimeter shrapnel shells.

COOPERATION BETWEEN A. S. M. E. AND WAR INDUSTRIES BOARD

Prior to the establishment of the regional organization of the War Industries Board, the American Society of Mechanical Engineers established its War Industries Readjustment Committee, the purpose of which is to aid manufacturers throughout the country in keeping their plants busy on war work, especially in cases where non-essential industries have been either partially or totally closed down by war conditions. These plants should be employed, and the committee appointed by the society intends to aid in this work by securing for these manufacturers information relating to direct government contracts or subcontracts from other manufacturers.

When Charles A. Otis assumed the work of the Resources and Conversion Section of the War Industries Board he proceeded to organize all the industries of the country in a manner that will accomplish the same end as that aimed at by the society's War Industries Readjustment Committee. There has been established in each of the twenty regions into which the country has been divided a great organization cooperating with the regional advisor. This organization is called the War Resources Committee. This committee is organizing each of the trades in its region by establishing committees of manufacturers representing the various trades. The society's committee, therefore, offered to cooperate with the regional advisors appointed by Mr. Otis.

The president of the American Society of Mechanical Engineers, Charles T. Main, has appointed a regional representative of the society in each of the twenty regions to cooperate in every possible way with the regional advisor appointed by Mr. Otis, and with the several War Industries Committees. The representatives of the American Society of Mechanical Engineers are particularly well equipped to take care of engineering investigations, surveys of plants and similar propositions which require engineering knowledge. The society's War Industries Readjustment Committee immediately upon the formation of the regional advisory system proceeded to turn over to the several regional advisors such correspondence and information as had been previously collected, and the society's committee now serves in a national capacity only as a clearing house of information for its regional representatives, so that they may be fully advised of the best methods that have been devised in other regions for cooperation between the society and the War Industries Board.

The society's War Industries Readjustment Committee which consists of G. K. Parsons, president, G. K. Parsons Corporation; Frederick A. Scheffler, sales engineer, Babcock & Wilcox Co.; and Erik Oberg, editor of MACHINERY, has offices at 29 Pine St., New York City, at the place of business of its chairman, G. K. Parsons, to whom all mail should be addressed. Manufacturers who are in a position to take on work necessary to the conduct of the war should communicate with Mr. Parsons and should indicate the specific kind of article that they would be capable of manufacturing with their present facilities. As the Government is discouraging all new building construction at the present time, no one should figure on contracts that would require additions to present facilities as far as buildings are concerned; but a limited amount of machine tools might be added to the present equipment in order to manufacture any one line of articles. It is suggested that manufacturers themselves select the kind of articles that their shop is fitted to handle and then write to Mr. Parsons, stating definitely what they can do. This information will then be forwarded to the respective regional advisors with such recommendations as the engineering committee deems advisable.

In order to indicate the kind of work that the committee has already accomplished, mention may be made of the following investigations that have been carried on in regional organization No. 3, which includes New York City and the metropolitan district of New Jersey and New York:

1. To determine whether a certain corporation produces a product essential in character and to investigate into its probable future requirements, in order to determine whether an increase in the capital stock is warranted.
2. To determine the fitness of certain plants for the manufacture of products which had never been manufactured there before, and the ability of the management to make the specific articles that the Government would require to have made.
3. To study various industries to determine what kind of essential work they would be best adapted to do.
4. To determine, in the case of new building projects, whether the buildings are essential to the conduct of the industries during the period of the war, and whether the construction is such as to use the smallest amount of steel possible for the requirements of the building.

Below is given a complete list of the regional advisors of the War Industries Board and of the regional representatives of the American Society of Mechanical Engineers War Industries Readjustment Committee:

American Society of Mechanical Engineers' Regional Representatives of its War Industries Readjustment Committee

Boston	A. C. Ashton, 33 Columbus Ave., Somerville, Mass.
Bridgeport	Harry E. Harris, Post Office Box 852
New York City	G. K. Parsons, 29 Pine St.
Philadelphia	C. N. Lauer, care of Day & Zimmerman
Pittsburg	J. M. Graves, 435 Sixth Ave.
Rochester	Ivar Lundgaard, 208 Culver Road
Cleveland	F. H. Vose, 3203 Whitehorne Road, Euclid Heights
Detroit	E. J. Burdick, 511 Seminole Ave.
Chicago	A. D. Bailey, 21 Elmwood Ave., LaGrange, Ill.
Cincinnati	Fred A. Geier, 2301 Grandview Ave., E. W. H.
Baltimore	William W. Varney, 710 N. Carey St.
Atlanta	Robert Gregg, 960 Ponce de Leon
Birmingham	W. P. Caine, care of Tenn. Coal, Iron & R. R. Co., Ensley, Alabama
Kansas City	J. L. Harrington, Rockhill Manor
St. Louis	R. L. Radcliffe, 701 Laclede Gas Bldg.
Milwaukee	W. M. White, 747 Summit Ave.
Dallas	A. C. Scott, Scott Engineering Co.
San Francisco	B. F. Raber, 2027 Delaware St., Berkeley, Cal.
Seattle	R. M. Dyer, Puget Sound Bridge & Dredging Co.
St. Paul	Oliver Crosby, 63 S. Robert St.

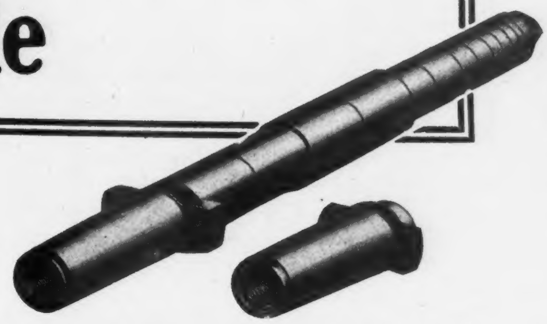
War Industries Board's Regional Advisors

Boston	Stuart W. Webb, care of Chamber of Commerce
Bridgeport	B. D. Pierce, Jr., First Bridgeport Nat'l Bank Bldg.
New York	William F. Morgan, Merchants Association of New York
Philadelphia	Ernest T. Trigg, 1228 Widener Bldg.
Pittsburg	George S. Oliver, Chamber of Commerce
Rochester	E. A. Fletcher, Chamber of Commerce
Cleveland	W. B. McAllister, Chamber of Commerce
Detroit	Allan A. Templeton, Detroit Board of Commerce
Chicago	D. E. Felt, 29 S. LaSalle St.
Cincinnati	Edwin C. Gibbs, 31 E. Fourth St.
Baltimore	S. F. Shavannes, Merchants & Manufacturers Association
Atlanta	Edward H. Inman, Chamber of Commerce
Birmingham	T. H. Aldrich, 322 Brown-Marx Bldg.
Kansas City	Franklin D. Crabbs, Tenth and Central Sts.
St. Louis	Jackson Johnson, 510 Locust St.
St. Paul	D. R. Cotton, 1414 Pioneer Bldg.
Milwaukee	August H. Vogel, 4th Floor, City Hall
Dallas	Louis Lipsitz, 407-9 Southland Life Bldg.
San Francisco	Frederick J. Koster, Chamber of Commerce
Seattle	Herbert Witherspoon, Chamber of Commerce

* * *

Tests have recently been made by the Vulcan Soot Cleaner Co. to determine the strength of iron and steel at high temperatures. The results show that as the temperature is increased, steel, wrought iron, and cast iron grow stronger up to a certain point. The maximum strength of wrought iron is reached at 450 degrees F. and the corresponding temperature for steel is 525 degrees F. With further increase in temperature, both the ultimate and elastic strength decreases rapidly. At 1000 degrees F., the strength of wrought iron is seriously diminished and steel has no elastic strength. The diminution of the strength of cast iron on the other hand, is much less in the same temperature range.

Taper-nose Spindle



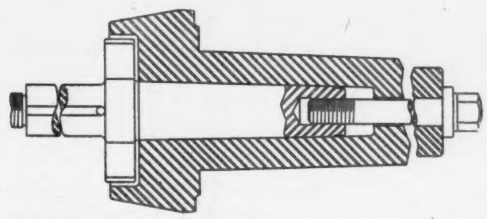
Arbors and Collets are clutch driven. Note clutches.

Only a Drawing-in Bolt
Required to Hold
Arbors and Collets

STEADY DRIVE

The spindles of

Brown & Sharpe Milling Machines

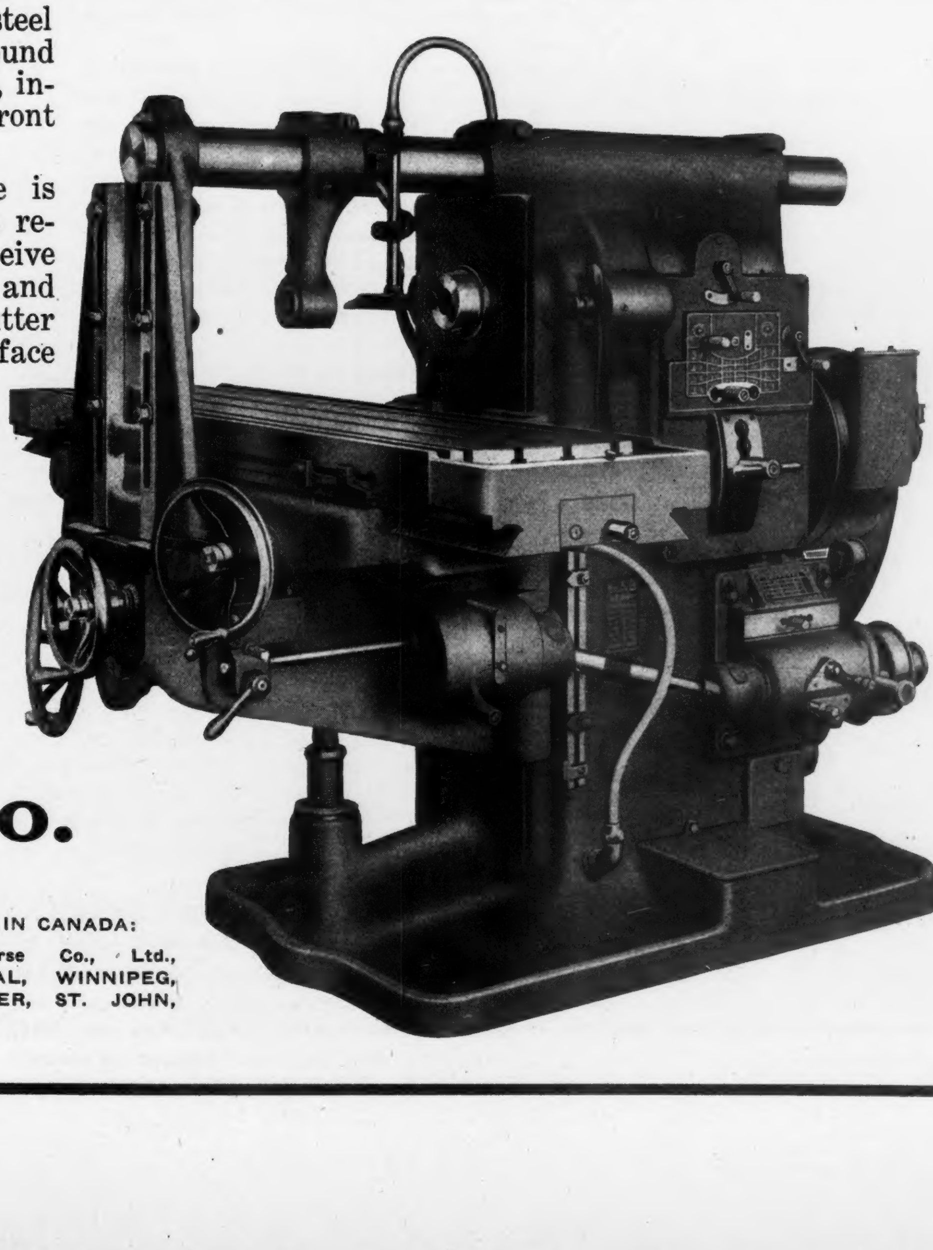


Method of drive as applied to arbors. Collets are driven in the same manner.

are of crucible steel hardened and ground on the front end, including the front bearing.

Nose of spindle is tapered and has recess in end to receive clutch on arbors and collets and cutter driver used with face milling cutters.

Arbors and collets are held securely in place by drawing-in bolt. Same drawing-in bolt is used for holding cutter drivers.



Mfg. Co.

R. I., U. S. A.

REPRESENTATIVES IN CANADA:

Canadian Fairbanks-Morse Co., Ltd., TORONTO, MONTREAL, WINNIPEG, CALGARY, VANCOUVER, ST. JOHN, SASKATOON.

ENEMY PATENTS, TRADEMARKS, AND DESIGNS

The Alien Property Custodian requests that any information readers of MACHINERY may possess regarding enemy interests in any patents, trademarks, copyrights, prints, labels, or designs be forwarded immediately to Francis P. Garvan, director of the Bureau of Investigation, Alien Property Custodian's Office, Washington, D. C., even if the information is based on a rumor. Oftentimes a clue to important enemy interests is obtained in this way. Under the Trading with the Enemy Act, the following persons must report to the office of the Alien Property Custodian: All persons who are in any manner interested in the use of or operation of any enemy-owned patent, trademark, copyright, print, label, or design, including joint inventors, where one of the inventors is an enemy within the provisions of the "Trading with the Enemy Act"; assignees of an undivided part or share of an invention, or right to carry on a process or operate under a trademark, copyright, print, label, or design within and throughout a specified portion of the United States when such patent or process is enemy-owned; mortgagees and licensees of enemy-owned patents, trademarks, copyrights, prints, labels, or licenses. The foregoing includes guardians, executors, and administrators.

* * *

According to a recent Commerce report, a group of Cuban capitalists interested in a number of mining properties in the Dominican Republic, have recently organized the Perseverance Nickel Co. for the purpose of mining the nickel deposits of the Perseverancia Mine situated at Sierra Prieta nineteen miles northwest of Santo Domingo. A few miners have already been brought in from Cuba and they are engaged in the preliminary work necessary before mining operations can be commenced. Assays of the ore have shown the property to be what is known as a "low-grade mine." This means it must be worked on a large scale and is what the engineers call "a steam-shovel proposition." A line for a railroad from the mines to La Piedra on the Ozana River, has been located and staked out. The distance is approximately thirteen miles and the maximum grade is 2 per cent. The company reports that it is contemplating the erection of a smelter, but as it will have to be a hydro-electric plant, the problem of obtaining the required material at present may delay this work until after the war. However, rapid progress is being made and it is hoped that shipments of mineral will soon be made.

* * *

WHO CAN EQUAL THIS?

W. T. Emmes, of the Boye & Emmes Machine Tool Co., Cincinnati, Ohio, has six sons in his country's service, and there is still a seventh son who, his mother says, is ready when the Government needs him, although he has lost the sight of one eye and has not claimed exemption on account of that. There are nine sons and five daughters in the Emmes family, and if there is any other family in the machine tool industry that has as splendid a record we should like to hear from it.

What Employers Can Do in the Organization of War Savings Societies

It is a generally accepted fact that the employes of any company who have been encouraged to be careful in their expenditures, to save their money and to invest it judiciously do better work, have greater pride in their jobs, and greater loyalty to their employers. The United States Government now offers employers an unusual opportunity for the systematic organization of their employes for THRIFT through the founding of War Savings Societies.

Group Saving through War Savings Societies bolsters up esprit de corps. It encourages economy in personal and company expenditures. It develops loyalty to company and country. The organization of a War Savings Society among your employes will be a direct help in winning the war, not only because it helps directly in Government financing, but also because it releases men, money, and materials for essential war work through the saving on non-essentials.

Perhaps you have not thought of a War Savings Society for your employes in just this way before. Why not organize a company of savers among your employes under your leadership and turn it over to the Government?

RELATION OF GOOD LIGHTING TO SAFETY

Since the workmen's compensation laws have been enacted and insurance companies have assumed the employers' liability, the accident investigations of the insurance companies have proved that many accidents previously ascribed to various causes are directly due to inadequate lighting. The public is familiar with the plotted charts that show the increase of the accident rate with the decrease in length of the daylight working day. Such charts strongly indicate that artificial light influences the safety of industrial workers, but they do not prove it. The insurance companies, however, have gathered the evidence in a manner which leaves no room for doubt, and which shows that poor lighting has been directly or indirectly the cause of an enormous amount of serious and fatal casualties. A well-lighted factory is given preference for group insurance, whereas a poorly lighted shop is penalized from 2 to 5 per cent of the premium, insurance being issued only on condition that the lighting be improved. Insurance companies have, without question, an indisputable argument for better lighting.

As an illustration, the state of Wisconsin has, through its Industrial Commission, accumulated data from which it is estimated that for the year 1915 sufficient time was lost in the factories of the state through industrial accidents to be equivalent to 6300 workmen being unemployed for a whole year. The salary value of these men for that time was $3,000,000. During that year, workmen received $1,000,000 in compensation for injuries. If it is agreed that of this total loss, amounting to $4,000,000, one-quarter—which is a conservative estimate—can be attributed to inferior lighting, then we have a loss from this cause of $1,000,000 a year in one state. No more convincing illustration of the actual value of proper illumination could be given, showing insurance companies as well as employers, the economical advantage of avoiding accidents by the provision of ample light.

M. E.

* * *

MUNITIONS WORKERS WANTED

There is a great demand for workers in existing munition plants. Nathan A. Smyth, assistant director general of the United States Employment Service, Washington, D. C., has made a request for 139,000 workers for munition plants alone, and an even greater number is required for the army construction projects. These men can be obtained only from the non-essential industries, and it is necessary that in all such industries men be released for government work, and women be trained to replace the men.

* * *

POSTPONEMENT OF THE NATIONAL MACHINE TOOL BUILDERS' CONVENTION

The convention of the National Machine Tool Builders' Association which was to have been held November 7 and 8 at the Hotel Astor, New York City, has been postponed indefinitely on account of the epidemic of influenza.

NEW BOOK ON MEASURING AND GAGING

GAGES, GAGING, AND INSPECTION. By Douglas T. Hamilton. 295 pages, 6 by 9 inches; 195 illustrations. Published by The Industrial Press, 140-148 Lafayette St., New York City. Price, $2.50.

This book comprises a comprehensive treatise covering the limit system, measuring machines, and measuring tools and gages for originating and comparing measurements in the manufacturing and inspection departments, including means for measuring and inspecting screw threads and gears. In dealing with this broad subject, the principles of the limit system are first covered, and then the different kinds of measuring machines and reference and working gages are illustrated and described. Gages of many different types are included—plug and ring gages, profile gages, indicating gages, thread gages, and devices for measuring gears of different kinds. The book should, therefore, appeal to those responsible for the output of shops manufacturing on the interchangeable plan, inspectors, foremen, designers of special measuring tools, toolmakers, and others whose duties are in one way or another connected with the problems of interchangeable manufacture, the gages used, and the inspection methods required.

This book is of especial value because no book has been published in the past dealing exclusively with this subject, nor dealing comprehensively enough with it to meet the requirements at the present time. The intensive manufacture of arms and ammunition during the past few years has also more than ever indicated the necessity of accurate and reliable means of gaging and inspection, and the introduction of the limit system has changed many of the methods previously in vogue. In fact, the development of interchangeable manufacture has made necessary a complete revolution in the gaging and inspection systems employed in many of the mechanical industries, and this book has been published with a view to covering the principles and the practical application of the limit system of interchangeable manufacturing and describing the principal tools and gages that are employed in this work in leading manufacturing establishments in the country. It will, therefore, be a distinct addition to the mechanical library of men engaged in this work.

The contents of the book are divided into the following seven chapters: Reference Standards and Measuring Machines; Limits and Tolerances; Reference, Working, and Inspection Gages; Profile Gages; Indicating Gages; Gaging and Inspecting Screw Threads; and Gaging and Inspecting Gears.

* * *

EFFECT OF TITANIUM IN STEEL

Titanium is one of the metallic chemical elements that has been successfully used to improve the quality of steel. Titanium combines with the nitrogen and oxygen contained in molten steel, and when added at the time of pouring into the ladle causes these gases to pass off into the slag as nitrides and oxides; this action is less marked with open-hearth steel, but basic steel is known to have been improved in this way. In the days when Bessemer steel was more generally used, ferro-titanium was often employed to improve the strength and wearing qualities of steel. The replacement of the silicon in iron by titanium is not an advantage. However, the strength and abrasive resistance of rail steel are remarkably increased by adding in the ladle 1.7 pound of titanium (as an iron alloy) per ton of steel.

* * *

The War Service Committee of the Ball Bearing Industry and the Steel Ball Industry, of which W. M. Nones, 1790 Broadway, New York City, is chairman, announces that the Priorities Division of the War Industries Board, in circular No. 19, dated September 3, 1918, has placed manufacturers of ball bearings and steel balls on the Preference List with a rating of Class B 3, conditioned upon their executing and filing pledges of cooperation with and observance of the rules of the Priorities Division.

PERSONALS

E. G. ANDERSON, sales manager of the American Bronze Corporation, Berwyn, Pa., has been appointed advertising manager.

JACK WELLER, for some time with L. Weller & Sons, has joined the New York sales force of the International Oxygen Co., succeeding Mr. Barnitz.

PHILLIPS WESLEY has been appointed manager in charge of the oxy-hydrogen plant and sales office of the International Oxygen Co. at Pittsburg, Pa.

HORACE N. TRUMBULL, advertising manager of the S K F Ball Bearing Co., Hartford, Conn., has entered the Reserve Officers' training camp at New Haven.

ROBERT MAWSON has recently been appointed general superintendent and production manager of the Mosler Safe Co., Ordnance Department, Hamilton, Ohio.

B. H. TRIPP has been appointed district manager of sales for the Pacific coast territory of the Chicago Pneumatic Tool Co. of Massachusetts, succeeding M. W. Priseler.

C. D. MORTON has left his position as sales engineer for the Page Steel & Wire Co., New York City, to become a captain in the General Engineer Depot, United States of America, at Washington, D. C.

G. L. HANSON has purchased an interest in the Advance Machinery Co., Van Wert, Ohio, manufacturer of milling cutters, reamers, small tools, etc., and has become manager of the concern. Mr. Hanson has had wide experience in this line.

GEORGE QUELCH, one of the staff engineers of the International Oxygen Co., 115 Broadway, New York City, sailed recently for England to supervise the installation of a 480-cell plant of I. O. C. unit oxy-hydrogen generators for the British Admiralty.

C. H. BAKER, formerly auditor of the Timken Roller Bearing Co., Canton, Ohio, has been appointed assistant to Matthew C. Dittmann, general manager of the American Bronze Corporation, and will be in charge of the financial and accounting departments.

MATTHEW C. DITTMANN, vice-president and treasurer of the American Bronze Corporation, Berwyn, Pa., has been appointed general manager at a recent meeting of the board of directors. Mr. Dittmann has been associated with the organization for nine years.

FRANK P. FAHY, consulting magnetic engineer, Hudson Terminal, New York City, has been awarded the John Scott legacy medal and premium by the city of Philadelphia, acting on the recommendation of the Franklin Institute, for the development of the Fahy permeameter.

LLOYD H. ATKINSON has resigned as vice-president of the Air Reduction Co., Inc., 120 Broadway, New York City. Mr. Atkinson has been in poor health for some time, as a result of overwork, and will take an extended vacation before engaging in one of the war service activities.

E. P. COOKE has assumed the duties of sales manager of the Fawcus Machine Co. with headquarters at the Pittsburg office. Mr. Cooke still retains his interest in the Armstrong Cooke Steel Co. which he organized after leaving his engineering position with the Corn Products Co. of Chicago.

FRANK H. BROWN, one of the founders of the Brown & Zortman Machinery Co., Pittsburg, Pa., and more recently with the Davis Machine Tool Co., Rochester, N. Y., is now sales manager with the Sherritt & Stoer Co., Philadelphia, Pa. Mr. Brown is widely known in the machine tool industry.

CHARLES E. GOODNOW, formerly assistant sales manager of the electrical and special wire department of the American Steel & Wire Co., and more recently identified with building construction work in Washington and Brooklyn for the Army and Navy, is now with the Page Steel & Wire Co., 30 Church St., New York City. Mr. Goodnow will have charge of the sales of "Armco" iron welding rods and "Copperweld" electrical wire.

R. E. CARPENTER, sales manager for the past fifteen years of the Taft-Peirce Mfg. Co., Woonsocket, R. I., has left that company to become Director of Service with the Aluminum Castings Co., Cleveland, Ohio. In his new capacity, Mr. Carpenter will reorganize the inspection systems at the various plants owned by the company, and will install new systems of foundry inspection. He will also be in charge of the Aluminum Castings Co.'s research department in Cleveland.

ROBERT C. BYLER, for nearly four years advertising production man for the S K F Ball Bearing Co., Hartford, Conn., has been appointed advertising manager of the S K F Administrative Co. of New York City, and will direct the advertising of the S K F Ball Bearing Co. of Hartford, the Hess-Bright Mfg. Co. of Philadelphia, and the Atlas Ball Co. of the same city, all of which are controlled by the S K F Administrative Co. Until arrangements are made in New York City, Mr. Byler will remain with the S K F Ball Bearing Co. of Hartford.

JOHN W. WATSON, president of the American Bronze Corporation, Berwyn, Pa., and former chairman of the Pennsylvania section of the Society of Automotive Engineers, has been appointed assistant chief of the Hispano-Suiza section of the Bureau of Aircraft Production. In the absence of B. D. Gray, chief of the Hispano section, Mr. Watson is entirely responsible for the administration of the particular section, which includes all engineering, production, and inspection activities for the Government in connection with the production of Hispano-Suiza engines. Mr. Watson will make his headquarters in New York City.

OBITUARIES

LEANDER J. HOOVER

LEANDER J. HOOVER, president and general manager of the Hoover Steel Ball Co., Ann Arbor, Mich., died September 23, after a few weeks' illness, aged forty-two years. Mr. Hoover started work at an early age with the Cleveland Machine Tool Co., where his quickness and interest in the tasks allotted to him attracted the attention of John J. Grant, one of the most prominent men in the development of the American steel ball industry. Mr. Hoover steadily worked up in the ball bearing industry, and became associated with the Grant Ball Co., Grant Hoover Co., Standard Roller Bearing Co., and Flanders Mfg. Co. In 1913, he founded the Hoover Steel Ball Co. While much of Mr. Hoover's time was devoted to the steel ball industry, his activities in other lines covered a wide scope. He was vice-president of the Parker Mfg. Co., president of the American Plug Co., president of the King Trailer Co., president of the Ever-Tite Nut Corporation, director of the Heath Carburetor Co., vice-president of the Mulkey Salt Co., and president of the Forge Products Corporation. Mr. Hoover always manifested deep interest in the welfare of his employes. His widow and two daughters survive him.

Leander J. Hoover

JOHN P. HOPKINS, chairman of the Board of Directors of the Independent Pneumatic Tool Co., Chicago, Ill., and former mayor of Chicago, died in that city October 13, aged sixty years. He was ill only a few days and died from heart trouble superinduced by an attack of Spanish Influenza. Mr. Hopkins was born in Buffalo, N. Y., in 1858. He went to Chicago in 1880 and obtained a position with the Pullman Palace Car Co. as a machinist. Later he went into business for himself as a partner in the firm of Secord & Hopkins, at Pullman, Ill. In 1905, he became interested in the Independent Pneumatic Tool Co. He was one of the original organizers of the company and was the largest stock-holder.

CHARLES GUSTAVUS ROEBLING, president of the John A. Roebling's Sons Co., and of the New Jersey Wire Cloth Co., of Trenton, N. J., and vice-president of the John A. Roebling's Sons Co., New York City, died October 5 at his home in Trenton, aged sixty-nine years. Mr. Roebling was born in Trenton. He graduated from the Rensselaer Polytechnic Institute in 1871 and was for a number of years mechanical engineer of the John A. Roebling's Sons Co. He and his brother had an active part in the construction of the Brooklyn Bridge which was started by his father, John A. Roebling. He was also connected with many other engineering projects.

SHERMAN C. SCHAUER

SHERMAN C. SCHAUER, vice-president and general manager of the Cincinnati Bickford Tool Co. of Cincinnati, Ohio, died on October 11. Mr. Schauer was born at Hamilton, Ohio, November 13, 1865, and after completing a common school course entered the drafting-room of the Cope & Maxwell Co., pump manufacturers. It was not long before he realized the necessity for a more practical knowledge of machine shop work than this position afforded, so he went with the Bentel & Margedant Co., manufacturers of woodworking machinery, as an apprentice machinist, and equipped with the experience thus acquired, went to Cincinnati with the old Lodge & Davis Co., and later with the Lane & Bodley Co.

Sherman C. Schauer

Mr. Schauer's earliest business venture was at Aurora, Ind., whence he returned to Hamilton to become superintendent of the Hamilton Machine Tool Co., where he remained for eight years. In 1898, in connection with August H. Tuechter, Mr. Schauer founded the Cincinnati Machine Tool Co., for the manufacture of upright drilling machinery, and made many valuable practical improvements in the product of his company. In 1909, the Cincinnati Machine Tool Co. was consolidated with the Bickford Drill & Tool Co. under the name of the Cincinnati Bickford Tool Co., with August H. Tuechter, president; Sherman C. Schauer, vice-president and general manager; George P. Gradolf, secretary and treasurer, and H. M. Norris, mechanical engineer.

Mr. Schauer was highly regarded by a wide circle of personal and business friends as well as by his associates and employes in the great business which his mechanical ability and untiring energy helped to build up. He is survived by his widow, three sons, and one daughter.

EDWARD H. BROWNELL, treasurer of E. P. Reichhelm & Co., Inc., and the American Gas Furnace Co., 24-26 John St., New York City, and vice-president and treasurer of the American Swiss File & Tool Co., died on October 14 in Brooklyn, N. Y. Mr. Brownell was born in Brooklyn in 1855 and had all his life been in business in New York City. He was a man of sterling character and unusual ability and will be greatly missed by the E. P. Reichhelm Co., of which he had been a member since 1907.

ALBERT P. WEIGEL, president and general manager of the Weigel Machine Tool Co., Peru, Ind., died September 16 from typhoid fever, at the age of fifty. Mr. Weigel was general manager of the Superior Machine Tool Co., Kokomo, Ind., for eleven years, and previous to his connection with that company, was superintendent of the Aurora Tool Works, Aurora, Ind., for ten years. He was one of the founders of the Weigel Machine Tool Co. The company will continue business under its present organization.

COMING EVENTS

December 3-6—Annual meeting of the American Society of Mechanical Engineers at 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

University of Missouri, School of Mines and Metallurgy, Rolla, Mo. Bulletin containing the annual commencement address delivered by James Furman Kemp, Professor of Geology, Columbia University, in May, 1918, entitled "The Human Side of Mining Engineering."

BOOKS AND PAMPHLETS

Tests to Determine the Rigidity of Riveted Joints of Steel Structures. By Wilbur M. Wilson and Herbert F. Moore. 55 pages, 6 by 9 inches; illustrated. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 104. Price, 25 cents.

Some Fundamentals of Rolling Support. By F. W. Gurney, chief engineer of the Gurney Ball Bearing Co., 23 pages, 6 by 9 inches; illustrated. Reprint of a paper read before the Society of Automotive Engineers at Indianapolis. Distributed by the Gurney Ball Bearing Co., Jamestown, N. Y.

Variance of Measuring Instruments and its Relation to Accuracy and Sensitivity. By Frederick J. Schlink, assistant physicist of the Bureau of Standards. 23 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 328 of the Bureau of Standards. Price, 5 cents.

Evening Industrial Schools. 54 pages, 6 by 9 inches. Published by the Federal Board for Vocational Education, Washington, D. C., as Bulletin No. 18 of the Trade and Industrial Series No. 2.

This bulletin has been prepared by L. H. Carris, assistant director for industrial education. The purpose is to describe possibilities in evening industrial school work and to give suggestive courses which have been prepared and carried out in certain evening schools where effective work has been done.

Handbook of Mechanical and Electrical Cost Data. By Halbert P. Gillette and Richard T. Dana. 1716 pages, 4¾ by 7 inches; numerous illustrations. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $6.

This handbook contains a mass of information relating to costs in the mechanical and electrical industries, covering particularly such subjects as shipping weights, capacities, outputs, and net prices of machines and apparatus and detailed costs of installation, maintenance, depreciation and operation, together with many principles and data relating to engineering economics. The principal reason, the authors state in the preface, for the publication of this material and for the belief that it will be found useful by others is that it has been useful and, in fact, indispensable in their own practice as consulting engineers, and that it is not available in other form. The civil engineering field has, in the past, been provided with two handbooks relating to costs, but the mechanical and electrical field has not had any book on this subject. The practical requirements of the designer, appraiser, chief of construction, superintendent of operation, and the engineering student have been kept particularly in mind, and the main purpose of the book is to place before the engineer, in the most convenient form for reference, the largest practical amount of information bearing upon the economic factors involved in mechanical and electrical engineering. As far as possible, the material has been classified along the lines of the work that one man is likely to be called upon to handle at any one time. In addition, the work is provided with an index. The subject matter in the book is divided into twenty-one specific chapters headed as follows: General Economic Principles—Depreciation, Repairs, and Renewals—Buildings—Chimneys—Moving and Installing—Fuel and Coal Handling—Steam Power—Internal Combustion Engines and Gas Producers—Hydro-electric Plants—First Cost and Operating Expenses of Complete Electric Light and Power Plants—Overhead Electrical Transmission and distribution—Underground Electrical Transmission and Distribution—Lighting and Wiring—Belts, Shafts, and Motor Drives—Compressed Air—Gas Plants—Pumps and Pumping—Conveyors, Hoists, Cranes, and Elevators—Heating, Cooking, Ventilating, Refrigerating, and Ice Making—Electric Railways—Miscellaneous.

As the authors have specialized in cost data for more than twenty years and have a personal knowledge of the subject this gives an authoritative standing to the book. It is evident, of course, that much of the data in the book has been collected from other sources besides the authors' own experiences. It is often believed that a book on costs needs rewriting every time wages and prices change. If this were true, a cost book would scarcely be off the press before rewriting would be necessary, for the prices of some things change every month. The authors have gone to considerable trouble in the introduction, Chapter I, to show how cost data are usable even where wages and prices have changed since the compilation of the cost data. Those who are inclined to criticize any given cost on the score that it is "not up to date" are requested to read the first part of this introduction with care.

The one criticism of the book that seems valid is that the index is not carried out in detail as completely as might be desirable. Too many references by page number are given to single items, making it necessary to spend considerable time, in certain cases, to find a specific item. In a book of this kind, nothing adds more to its general usefulness than that the index is carried out in such detail that every available item in the work may be rapidly located. The improvement suggested in the index, however, does not detract from the credit that is due the authors for having compiled in such usable form the great amount of cost data placed on record in this work.

NEW CATALOGUES AND CIRCULARS

Cleveland Milling Machine Co., Cleveland, Ohio. Stock list of standard milling cutters.

Hanson Clutch & Machinery Co., Tiffin, Ohio. Catalogue P-1 of friction clutch pulleys, giving tables of dimensions and prices.

Norwich Wire Works, Inc., Norwich, N. Y. Circular advertising wire belt guards for safeguarding moving parts of machinery.

Tate-Jones & Co., Inc., Pittsburg, Pa. Catalogue showing a number of installations of the Tate-Jones heat-treating furnaces of large capacity.

C. H. Tracey Co., 161 Summer St., Boston, Mass. Folder descriptive of the Beckett universal angle fixture for use on drilling, milling, and grinding machines, planers, and shapers.

Kempsmith Mfg. Co., Milwaukee, Wis., is issuing a house organ called "Kempsmith Komments," giving information concerning this plant, its product, and items of personal interest to the employes.

Aluminum Castings Co., 6205 Carnegie Ave., Cleveland, Ohio. Circular entitled "You Never Know What It's Like on the Other Side of the Street Till You Cross Over," advertising "Lynux" bronze bushings and bearings.

R. D. King, Monadnock Block, Chicago, Ill. Folder descriptive of the King pressure toggle, a permanent attachment for punch presses, which is intended to equalize the pressure throughout the stroke and reduce breakage.

Bastian-Blessing Co., Austin Ave., at La Salle St., Chicago, Ill. Folder entitled "A New Principle in Welding and Cutting Apparatus," describing "Rego" welding and cutting torches, their advantages, and application.

Peter A. Frasse & Co., Inc., 417-421 Canal St., New York City. Revised catalogue of "Shelby" seamless steel tubes, giving tables of dimensions and price lists. The dimensions for standard stock sizes are printed in bold-face type.

Fulflo Pump Co., Blanchester, Ohio. Reprint of a circular entitled, "Fifteen Gallons Per Minute," containing additional matter, which includes illustrations and descriptions of "Fulflo" machine tool pumps and "Fulflo" grinder pumps.

Ogden R. Adams, 159-161 St. Paul St., Rochester, N. Y. Circular illustrating and describing the Adams "Short-cut" lathe which was designed to meet the demand for rapid production of duplicate parts of short length and comparatively small diameter.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Catalogue of "Nonpareil" high-pressure blocks and cement for enameling, japanning, and drying ovens, boilers, steam drums, feed-water heaters, tanks, and other heated surfaces. Copies will be sent to anyone interested.

Wetmore Mechanical Laboratory Co., Milwaukee, Wis. Leaflets 51, 52, and 53, describing and illustrating, respectively, Wetmore thread-milling hobs for shells; taps for shells, of the solid and expanding types; and expanding reamers of the floating type for finish-sizing fuse holes of shells.

Duplex Machinery Co., Cleveland, Ohio, is issuing a monthly list of second-hand machines carried in stock, including bolt cutters, boring mills, broaching machines, drilling machines, lathes, milling machines, planers, screw machines, shapers, punch presses, turret lathes, and other machine tools. This company also sells new machinery.

Hanson Clutch & Machinery Co., Tiffin, Ohio. Catalogue illustrating and describing Hanson friction clutches. Tables and price lists are given for friction clutch cut-off couplings, extended-sleeve friction clutches, phosphor-bronze bushings for sleeves, operating levers for friction clutches, machine clutches, high-duty countershafts and countershaft pulleys.

Williams Foundry & Machine Co., Akron, Ohio. Catalogue 10, describing the construction and operation of "Akron" friction clutches of the disk type, which are made in nineteen sizes for transmitting from 3/4 to 1000 horsepower at 100 revolutions per minute. Tables are included that give full data as to the power, dimensions, etc., of "Akron" friction clutches and clutch couplings.

Diamond Chain & Mfg. Co., Indianapolis, Ind. Catalogue describing the Diamond tooth form for roller chain sprockets, illustrated with halftones and line engravings. The catalogue also treats of the advantages of chain for the transmission of power, chain drive for motor trucks and tractors, design of a chain drive, and care of chains. A list and description of Diamond driving chain of the standard sizes and types is included.

Timken Roller Bearing Co., Canton, Ohio. Pamphlet entitled "Timken Primer—On the Care and Character of Bearings." This little book discusses the importance of anti-friction bearings in motor cars; places where they are used, and functions they perform; right principles of construction, and care. In connection with the discussion, a detailed description is given of the construction, principle of operation, and application of the Timken tapered roller bearing.

S. A. Woods Machine Co. and H. C. Dodge, Inc., Boston, Mass., are issuing a house organ entitled "Serving America" which is published in the interests and for the information of the employes of these companies. The first number of this publication contains a letter from the Chief of Ordnance, War Department, Washington, D. C., expressing the department's appreciation of the munition work done by this plant. This number also contains photographs showing shell inspection tables and shells ready for shipment, considerable material relating to the war and items of general interest to the employes.

Swedish Gage Co., Inc., 245 W. 55th St., New York City. Catalogue of Johansson gaging tools. The catalogue is divided into three sections headed: "Combination Gage-blocks," "Adjustable Limit Snap Gages" and "Tolerance Plug Gages—Standard Cylindrical Gages." A detailed description is given of the Johansson gage-blocks, and information as to how they are combined, how to figure combinations, and applications. The book is illustrated with excellent halftones which make the application of this system very clear. Tables of dimensions of the Johansson blocks in various sets are given, as well as dimensions and prices for the Johansson snap gages. Information is also given on Johansson methods of lapping and heat-treating as applied to plug and ring gages.

Graton & Knight Mfg. Co., Worcester, Mass. New book entitled "Standardized Leather Belting," explaining the value of standardizing belting as well as other machine parts, and telling how standardization of belting can be applied in any manufacturing plant. One section of the book contains a complete description of this company's standardized brands of leather belting, including recommendations for their use in all the principal industries of the country. Mechanical rules and tables are included which should be of value to belting users in determining the horsepower of belting, width and length required, and how belting should be ordered. The information given will aid the user in selecting the proper belt for different drives and various conditions of service. In preparing this book the aim has been to impress upon belting users the reasons why belting can be standardized, and the value and economy to be derived from purchasing belting on a definite, scientific basis for the work to be done. This book will be sent free to anyone interested in power transmission.

TRADE NOTES

Dayton Irrigation Co., Dayton, Ohio, is erecting a new shop, 50 by 150 feet, in Dayton.

O. R. Adams Mfg. Co., Rochester, N. Y., is erecting a building to facilitate the production of the Adams "Short-cut" lathe.

Taylor Machine Co., Cleveland, Ohio, has taken over the business of the Baxter Gear Cutting & Mfg. Co., and will conduct it under the name of Taylor Machine Co.

Speakman Supply & Pipe Co., Wilmington, Del., has changed its name to the Speakman Co. No change will be made in the policy, officers, or personnel of the company.

Giddings & Lewis Mfg. Co., Fond du Lac, Wis., manufacturer of the Giddings & Lewis horizontal boring machine, has added 5000 feet of floor space to its plant and is installing new equipment.

Special Tool Engineering Mfg. Co., Inc., (Stemco), Dayton, Ohio, has taken over the C. J. Weinman Co., Inc. The company will specialize in all high-class tool work, fixtures, and gages.

Cincinnati Pulley Machinery Co., Cincinnati, Ohio, manufacturer of "Avey" drilling machines and pulley lathes, has just completed a large addition to its plant that will double its capacity.

British Ministry of Munitions of War in the United States has removed its gage department and laboratory to 360 Madison Ave., New York City. Inspector in charge, H. J. Bingham Powell.

S K F Ball Bearing Co., Hartford, Conn., has purchased the factory and good-will for the Gronkvist quick-acting high-speed drill chuck of Sweden and will market it through the S K F organization at Hartford.

Modern Tool & Machine Works, Inc., designers and builders of dies, gages, jigs and fixtures, and machine tools, have removed their New York offices and factory to larger quarters in the Hobbs Bldg., 344-350 Mulberry St., Newark, N. J.

Hess Steel Corporation, Pennsylvania R. R. and East Ave., Baltimore, Md., announces that its employes subscribed for $29,000 worth of Liberty Bonds, and the company subscribed for $20,000 worth at a mass meeting held on the opening day of the Liberty Loan campaign.

Stuebing Truck Co., Cincinnati, Ohio, manufacturer of lifting trucks, is now located in its new plant at Mitchell Ave. and B. & O. Railroad, Winton Place, Cincinnati. The company has a modern building, 600 by 180 feet, and is in the market for lathes, drilling machines, punches, and shears.

Supreme Motors Corporation, Warren, Ohio, is erecting and equipping a motor plant in Warren, Ohio. Owing to war conditions the first unit only of this building will be erected at the present time. The company will confine its operations to the manufacture of war essentials until after the war at which time it is planned to build a complete line of motors. The officers of the company are A. W. Green, president; C. H. Davies, vice-president and general manager; C. F. Erickson, secretary; and C. N. Mitchell, treasurer.

Burton Engineering & Machinery Co., Spring Grove Ave. and Alabama St., Cincinnati, Ohio, has recently been organized to manufacture a 36-inch high-duty engine lathe. Large government contracts have been obtained and two and a half acres of ground has been purchased adjoining the shop now occupied. Machinery will be installed and in operation about November 5. The officers of the concern are Rufus C. Burton, president and treasurer; Robert L. McCabe, secretary; and W. S. Sweet, vice-president and general manager.

W. J. Crouch Co., Inc., and Rownson, Drew & Clydesdale, Inc., announce the amalgamation of their respective organizations. All trading and manufacturing operations will be conducted under the name of Rownson, Drew & Clydesdale, Inc., with general offices at 68 William St., New York City. P. G. Donald, president of Rownson, Drew & Clydesdale, Inc., will continue in this office, and I. Smullyan, president of the W. J. Crouch Co., Inc., will act as managing director of the new concern. Victor E. Karminski and A. E. Hearne, treasurer and general manager of the W. J. Crouch Co., Inc., and Rownson, Drew & Clydesdale, Inc., respectively, will act as joint general managers of the new company, Mr. Karminski conducting the Crouch steel division and Mr. Hearne directing all other trading operations. John J. Smart, secretary and assistant general manager of the W. J. Crouch Co., Inc., will have charge of the further development and expansion of the Rownson, Drew & Clydesdale engineering division. H. Lad Landau, assistant secretary and general sales manager of the W. J. Crouch Co., Inc., will continue in the same capacity, as will other leading officers of the company.

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